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Market and Non-Market Exchange: Complements or Substitutes?

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1

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Abstract

There is a long-standing debate about the relationship between market exchange, non-market exchange, and market-supporting institutions. Some intellectuals contend that markets reinforce certain conditions necessary to have a vibrant non-market exchange, while others argue that markets promote individualism and annihilate individuals in a way that displaces social ties and, thereby, non-market exchange. This paper shows that non-market and market exchange are complements, in the sense that both rise as the quality of market-supporting institutions improve, when the equilibrium payoff from market exchange rises with the quality of market-supporting institutions, the capital market is well developed, and the endowments is large enough so that individuals participate in both market and non-market exchange. Otherwise, they are substitutes.

Keywords: Market Exchange, Non-Market Exchange, Complementarity, Community, Market-supporting Institutions, Norms, Reputation.

JEL-Classification: D2, D3, C72, C73, D23, D73, H11, K12, O17, P48, P51, Z12

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> "The market community is the most impersonal relationship of practical life into which humans can enter with one another." And, "where the market is allowed to follow its own autonomous tendencies, its participants do not look toward the persons of each other ... there are no obligations of brotherliness or reverence, and none of those spontaneous human relations that are sustained by personal unions" (Weber, 1921, p. 76)

1 Introduction

There is long-standing debate about the relationship between market exchange, non-market exchange, and market-supporting institutions.[1] Coase (1937) and Williamson (1985) contend that market-supporting institutions serve to limit transaction costs; that is, they save time and money spent locating trading partners, facilitate price and quality comparisons, enforce trade agreements, and permit an efficient settling of controversies.[2] In short, make markets more efficient. McCloskey (2006) sustains that these also boost trust and social capital and, therefore, non-market exchange. Intellectuals such as Paine, Hume, Montesquie, and Condorcet have argued that markets reinforce durable and peaceful relations which favor non-market exchange. In contrast, since Karl Marx argued that markets promote individualism and corrode traditional values, scholars such as Weber (1921), Polanyi (1944), Anderson (1995), Sandel (2012), and Satz (2010) have advanced that the pervasive presence of markets changes moral values, culture, and institutions in a way that displace social ties and, thereby, non-market exchange.[3] The empirical and casual evidence is mixed.[4]

The critique that institutions favoring market exchange annihilates non-market exchange is the main focus of this paper. As such, this paper contributes to our understanding of how changes in formal institutions that govern production, market exchange, and credit affect the relationship between market and non-market exchange. The theory proposed in this paper uncovers a novel economic mechanism that links market and non-market exchange with market-supporting institutions.

Our framework assumes a community of members striped down from any moral consideration; i.e., they are homo-economicus agents, and endowed with limited resources. They engage in an

[1]Non-market exchange refers to the exchange of goods and services that takes place outside of the market. This can include bartering, gift-giving, and sharing economy transactions. These types of exchanges are often based on social relationships and may not involve the use of money. They can also be found in traditional, subsistence-based societies where a market economy does not exist. Market-supporting institutions are organizations that provide the rules and regulations necessary to ensure the efficient operation of markets. They include regulatory bodies, market infrastructure, and financial intermediaries. Regulatory bodies are responsible for setting rules and regulations that ensure the safety of markets and protect investors. Market infrastructure refers to the physical and technological infrastructure necessary for markets to function, such as exchanges, clearinghouses, and depositories. Financial intermediaries are institutions that serve as intermediaries between buyers and sellers, such as banks, brokers, and dealers.

[2]See, e.g., McMillan (2002) for a detailed discussion on this.

[3]See, Besley (2013) for a criticism of Sandel's (2012) arguments, and Hirschman's (1982) for the so-called self-destruction thesis, which asserts that markets, with their strong emphasis on individual self-interest, undermine traditional values including those on the basis of which the market itself is working and, thereby, result in self-destruction.

[4]See, for instance, Gagnon and Goyal (2017) for real life examples.

infinitely-repeated game, where in each period the play the following game: first, they choose how much to borrow in a perfectly competitive capital market, second, they decide ho much of the available resources (initial endowment plus borrowed funds) to divert. Divested funds are converted to private benefits at a rate lower than one. Hence, investments are non-contractible. Third, how much of the non-diverted resources to invest into each of the following different one-period actions: i) a spot market action, and ii) a non-market action.[5] The return and the marginal return to the market action depend on the market-action profile, which is composed by the action chosen by each community member, and the quality of market-supporting institutions. The payoff from the non-market action for any member is independent of his non-market action, depends positively on the non-market action chosen by the other members of the community, and is independent of the quality of market-supporting institutions. Also, there is perfect monitoring.[6] This is intended to capture the personalized, reciprocal, and self-sustained nature of non-market exchange. The univested resources are enjoyed with projects' payoffs and private benefits at the end of the period.[7] Because diversion possibilities, there is moral hazard in the credit market and the severity of it is measured by the rate of conversion of diverted resource into private benefits. The intensity of it is lower the better the quality of capital-market institutions. Hence, our setting considers the relationship between market exchange and non-market exchange in a setting where their payoffs are independent from each other, the payoff of non-market exchange is independent of market-supporting institutions, and that of market exchange depends positively on them.

The symmetric equilibrium in the one-shot game is such that no diversion takes place, and there is no investment in non-market exchange. Because the payoffs are certain and the diversion technology is linear, diversion is an all-or-nothing phenomenon. Therefore, in equilibrium, borrowing is incentive compatible, which means there is limited borrowing capacity. This capacity increases with the quality of capital-market supporting institutions. Members do not invest in non-market exchange since its payoff is independent of their own investment, increases with other members' investments, and is costly. There is an endowment threshold such that when the initial endowment is greater than or equal to the threshold, members are able to invest in the utility-maximizing market action. However, when the initial endowment is lower than the threshold, members invest all of their resources in the market action. In this equilibrium, there is no direct relationship between market and non-market exchange and market-supporting institutions, as no one invests in non-market exchange, despite its efficiency. However, there are other inefficiencies, one of which stems from the fact that members do not internalize market externalities. When externalities are positive, there

[5]For instance, this could be a crowdfunding project or any contribution to a collective action problem.

[6]The result will hold if we assume public monitoring and random matching as long as n does not go to infinity and in models with the network determine trade and information under certain network architecture, but this will complicate matters without further gain in intuition. See, Wolitzky (2013).

[7]To keep the analysis as simple as possible, we neither allow for savings nor for relationship lending. Hence, each period is identical to the preceding one and thereby we keep the model within the realm of repeated games.

is too little investment in the market action, while when they are negative, there is too much investment. While an improvement in the quality of market-supporting institutions leads to an increase in the payoff from the market action when externalities are taken into account, this might not be the case when externalities are not internalized. The payoff from the static game: i) rises with the initial endowment because the pass-through from this to the debt is higher than -1; ii) increases with the quality of market-supporting institutions when members are resource-constrained since the payoff from the market action rises, providing not only more consumption but also better access to external funds, and it may either rise or fall when members are unconstrained; and iii) is independent of the intensity of moral hazard in the capital market when members are unconstrained, otherwise it rises when externalities are not too positive.

A key aspect of the model is the fact that a member who reneges on non-market exchange can, however, keep engaging in market exchange as if the reneging never took place. Hence, the equilibrium payoff in the one-shot game determines the severity of the punishment for cheating in non-market exchange, as players use grim-trigger strategies. Consequently, the availability of a spot market where members can anonymously take profitable actions affects the enforceability of and gains from non-market exchange. The more efficient market exchange is, the harder it is for the community to enforce non-market exchange. The other key role is played by the spot credit market. Because the payoffs from market and non-market exchange can both be pledged to outside investors, the higher they are, the more can be borrowed, provided that borrowing is incentive compatible. This softens the incentive constraint in the credit market, allowing for higher borrowing and, as a result, larger market and non-market actions. Hence, despite the fact that the payoffs from non-market and market exchange are independent of each other, market and non-market exchange become linked through both the incentive-compatibility constraint regarding non-market exchange and the incentive-compatibility constraint regarding borrowing.

Because the repeated game has multiple equilibria, we focus on the equilibrium where community members prioritize market exchange in the following sense: whenever the resources (initial endowment plus borrowed funds) allow it, members invest the utility-maximizing amount in the market action. Otherwise, they invest the total resources in the market action. If there is a surplus of resources after this, they invest that in the non-market action according to the following rule: invest the welfare-maximizing amount whenever the resources allow it and this is self-sustainable. Otherwise, invest the minimum between the self-sustainable non-market action and the resource surplus.[8]

In the symmetric sub-game perfect equilibrium selected by this equilibrium-selection criteria, there is an endowment threshold such that when the initial endowment exceeds that, members par-

[8]Our results are robust to choose the welfare maximizing equilibrium, but we argue this equilibrium-selection criteria is more appropriate to study the problem at hand. Furthermore, if anything, this criterium provides the most adverse environment to get our result since exacerbates the crowding out of non-market exchange by market exchange.

ticipate in both market and non-market exchange. When the initial endowment falls short of the threshold, members play the one-shot game equilibrium strategy and do not participate in non-market exchange. When the payoff of market exchange rises with the quality of market-supporting institutions and the quality of capital-market institutions is high, improvements in market-supporting institutions result in more market and non-market exchange. However, when the credit market is riddled with moral hazard problems, better market-supporting institutions increase market exchange and decrease non-market exchange. Hence, market and non-market exchange are complements as the functioning of the market becomes more efficient, and individuals can engage in both market and non-market exchange when the initial endowment is not low, and the institutions governing credit market transactions effectively curtail moral hazard.

We emphasize that our results show that although market and non-market exchange substitute for each other obviously when the income constraint binds, when endogenous borrowing is taken into account, this does not preclude actions from being strategic complements. Thus, the co-movement of market and non-market exchange can be more powerful than the use or increase of one exchange alone. Making non-market exchange self-sustainable and market exchange more efficient increases pledgable income, thereby increasing the resources available for investment and enhancing the feasibility of both market and non-market exchange. When the increase in borrowing resulting from the improvement of market-supporting institutions compensates for the increase in investment in the market action due to the same reason, market and non-market exchange co-move with the quality of market-supporting institutions. This requires that the capital-market institutions responsible for curtailing moral hazard are effective at doing so and that market externalities are such that the equilibrium market payoff increases with the improvement of market-supporting institutions.

These results demonstrate that there are conditions under which the introduction and/or refinement of legal institutions to make market exchange more efficient does not lead to a collapse or displacement of non-market exchange. On the contrary, it enhances non-market exchange. Moreover, whether the improvement of a particular formal institution is efficient depends on preferences, technology, and the power of informal institutions (community enforcement). In fact, it is welfare-maximizing to invest in the quality of both market- and capital market-supporting institutions when initial endowments are not too large. When resources abound, capital markets are no longer needed, and therefore improvements in market-supporting institutions do not affect non-market exchange. They only result in larger welfare when the uninternalized market externalities are not too negative.

There is a theoretical literature studying the relationship between formal and community enforcement. For instance, Kranton (1996), Dixit (2003a,b), Acemoglu and Jackson (2017), and Jackson and Xing (2021), Wolitzky (2013), Acemoglu and Wolitzky (2020, 2021). Most of these paper introduce some kind of formal enforcement in repeated games models and study how that affect cooperation. For instance, Acemoglu and Wolitzky (2020, 2021) add agents specialized in coercive enforcement to a standard community enforcement repeated game model. The first one studies what sub-game perfect equilibrium maximize cooperation and show that grim triggers strategies fail to do so because they do not induce enforcement by specialized agents. The second uses the same model to study the emergence of legal equality. Dixit (2003a) shows that community enforcement can do worse than formal government enforcement in large size communities, the opposite occurs in small communities, and mid-size communities fare worst. Jackson and Xing (2021) in a repeated-task model with market and community tasks show that community and formal enforcement are complements. This stems from the fact that the news that someone was found out cheating on a market task results in a community punishment consisting on ostracism, which strengths incentives to comply. Their results rely on the fact that members can be ostracized if they do not take a particular market action, while ostracism plays no role in our complementarity result.[9] None of these papers is concerned with the relation between the quality of market-supporting institutions and market and non-market excahnge, rather they focus on how the introduction of some kind of formal enforcement crowds out community enforcement.

There is also evidence that the introduction of a formal credit market can erode social relationships and non-market exchange such as Banerjee, Breza, Chandrasekhar, Duflo, Jackson, and Kinnan (2021) and Heß, Jaimovich, and Schündeln (2020). The latter also finds that market exchange rises with the introduction of a formal credit market. This is consistent with our model when capital market are riddled with moral hazard problem and uninternalized market externalities are too large. Lowes, Nunn, Robinson, and Weigel (2017) find that centralized formal institutions are associated with weaker norms of rule following and a greater propensity to cheat for material gains. Greif and Tabellini (2017) also argue in favor of substitution in their study of China versus Europe. They conclude that the European system has a comparative advantage in supporting impersonal exchange, while the Chinese system has a comparative advantage in economic activities in which personal relations are more important. In contrast, Poppo and Zenger (2002) find evidence, using data from a sample of information service exchanges, that supports the complementarity between formal and informal enforcement. Namely, managers appear to couple their increasingly customized contracts with high levels of relational governance and vice versa.

There are also a literature concerned with the ability of communities or trade guilds to enforce informal agreements (Greif (1994), Greif, Milgrom, and Weingast (1994)) and others concern with this and the role of population size such as Dixit (2003a, 2004) and Bidner and Francois (2011). For

[9] Gagnon and Goyal (2017) ask a similar question but in a static network game where community self-enforcing punishment does not play a role. The game considers a market and non-market task in which individuals decide whether to engage in one of the two. The individual payoff of the non-market action depends on how many neighbors choose the non-market action and whether or not he undertakes a market action. The equilibrium depends on whether the network and market action are complements or substitutes, which is an exogenous parameter that fully determines this. They discuss several real-life interesting examples regarding when actions are complements or substitutes.

instance, Bidner and Francois (2011) study how the internalization of honesty norms and institutions that facilitate trade co-evolve over time. They conclude that trust strongly depends on the country population size, and that the institutional quality does not need to have a particular relationship with trust levels. This is due to the fact that the creation of institutions requires fixed costs and, thereby, introducing an institution becomes efficient just when the scale is big enough to cover the fixed costs of creating and running it (Demsetz, 1967).

There is also plenty of evidence of how formal enforcement, formal markets and states, can function well on a large scale under the proper circumstances (Acemoglu, Johnson, and Robinson (2001b), Persson (2002), Tabellini (2010), and Besley and Persson (2010)), and those institutions can be either enhanced or hampered by culture understood as beliefs and values (Bisin and Verdier (2017) and Alesina and Giuliano (2015)) or co-evolve with culture (see Aghion, Algan, Cahuc, and Shleifer (2010), Pinotti (2012), and Bidner and Francois (2011)). Acemoglu, Johnson, and Robinson (2001a) argue that the roots of development are based on the role of formal institutions. Greif (2006) studies the process of institution formation in European history. Aghion, Alesina, and Trebbi (2004) look at the formation of political institutions and its distributional effect. Becker, Boeckh, Hainz, and Woessmann (2016) show that the Habsburg Empire, with its well-respected administration, increased the citizens' trust in local public services.

Our paper differs from the previous literatures in that it investigates the relation between market-supporting institutions and market and non-market exchange, in a setting where a-priori they are completely independent from each other and both types of exchanges generate benefits and compete for funds rather than looking at circumstances under which either of them flourish. Furthermore, our model provides a novel economic mechanism under which market and non-market exchange interact strategically through the incentives they create and these depend on the quality of market-supporting institutions and income level. Both are observable variables that have been shown to be empirically important determinants of the degree of development of a society.

The rest of the paper is structured as follows. Section 2 presents the model. Section 3 provides two benchmarks, the welfare-maximizing and the static equilibrium. In Section 4, we derive the dynamic equilibrium. In Section 5, we study the complementarity/substitutability between market and non-market exchange. In the next Section, we discuss the robustness of the results. Section 7 concludes and briefly discusses future research.

2 The Model

We consider a repeated game between $n+1$ individuals/players, with common discount factor δ, is played. Individuals' goal is to maximize consumption at the end of each period. In every period $t = 0, 1, 2, \ldots$, individuals participate in the following sequential game: At the beginning of each time period t, each individual is endowed with an amount of resources equal to w. After that, they can simultaneously approach the spot credit market and ask for a loan that must be repaid at the end of the period. Then, they simultaneously choose how much of their own and borrow funds to divert and convert in private benefits. Once this is done they simultaneously chose how much of the non-divested resources to invest into any or both of the following two different actions: a non-market action and a market action. After the returns from the actions are realized, debt is re-paid, and net returns and diverted and uninvested resources are fully consumed. Thus, there is no saving possibilities and debt maturity is one period.

Non-market Action In each period t, if individual i invests $x_i \in \Re_+$ in the non-market action, he gets a payoff $-x_i$ and his investment benefits every other individual $j \neq i$ by an amount $f(x_i, n)$, where $f : \Re_+ \to \Re_+$ is an increasing, strictly concave, bounded, and differentiable function satisfying $f(0, n) = 0$ for all $n > 0$. Furthermore, for any $x_i > 0$, $f(x_i, n)$ is a decreasing, bounded, and differentiable function of the size of the network n.[10] We also assume that, for any $x_i > 0$, $nf(x_i, n)$ and $nf_1(x_i, n)$ are single peaked in n, where the sub-index denotes the partial derivative with respect to the corresponding variable. The strategy profile $x = (x_1, \ldots, x_n)$ is observable by each individual of the society. This implies that peer sanctions are possible; in their absence, individuals are not willing to invest in the non-market action. A nice example of this type of actions is crowdfunding, where people invest despite the fact that these types of projects are riddled with moral hazard problems and, thus, self-enforcing of agreements is needed for their success.[11] Another interesting example are rotating savings and credit associations (Roscas), which are informal financial institutions found all over the world and these institutions are primarily used to save up for the purchase of durable goods (see Besley, Coate, and Loury (1993) for a model of Roscas).

Spot Market Action In each period t, if individual i invests $y_i \in \Re_+$ in the market action, he gets a payoff $g^i(y_i, y_{-i}; \psi) - y_i$, where $\psi \in [0, 1]$ is a parameter that measures the quality of market-supporting institutions. This is interpreted as a reduced-form equilibrium payoff of unmodeled product-market game whose equilibrium depends on the investment made by market participants. The benefit function is strictly increasing in y_i, twice-continuously differentiable, strictly concave in $y \equiv (y_1, \ldots, y_n)$, and satisfies the following: $g^i_i(0, y_{-i}; \psi) > 1$ and $\sum_j g^i_{y_j}(0, y_{-i}; \psi) > 1$ for all y_{-i}. The first part ensures that is optimal in the static equilibrium to invest a positive amount on the

[10]We do not examine the role played by the size of the population in a community as those have been explored elsewhere (e.g., Dixit (2003a, 2004)), and assume that communities have mechanisms in place so that people are quickly aware of any deviations from the social norms of cooperation within their community. Yet, we briefly discuss this at the end of the paper.

[11]Moysidou and Hausberg (2020) empirically study how trust works in this kind of projects. Agrawal, Catalini, and Goldfarb (2015) show how crowdfunding platforms play an important role in diminishing distance-sensitive costs. Chang (2020) provides a theoretical explanation about the economic forces behind crowdfunding projects and the willingness to invest in them despite the moral hazard problem.

market action and the second one implies that is welfare maximizing to invest a positive amount in the market action. Furthermore, $g^i(0, y_{-i}; \psi) = 0$, $g^i_\psi(\cdot) > 0$, and $g^i_{i\psi}(\cdot) \geq 0$. Hence, as ψ rises, the marginal payoff as well as the payoff itself increases. Because of this, the inverse of ψ could represent, for instance, regulatory restrictions needed to operate a firm, or regulations affecting the firm's efficiency, such as taxes levied on actions, or regulations that impose rigidities in the relationship between employers and employees. The market payoff also satisfies the dominant diagonal condition; that is, for all $y > 0$, $g^i_{ii} + \sum_{j \neq i} |g^i_{ij}| \leq 0$ for all $i \in \mathcal{I}$ and $g^i_{i\psi} + \sum_{j \neq i} g^j_{i\psi} \geq 0$ for all $i \in \mathcal{I}$. Diagonal dominance together with strict concavity are sufficient for the welfare-maximizing market action to be monotone on the quality of the market-supporting institution ψ. A crucial feature of these markets is that enforcement is formal and not community driven. This requires unobservable market actions and a payoff structure that it does not allow to identify deviators. So, we could think of $g^i(y_i, y_{-i}; \psi)$ as the expected payoff when the market action profile is y and the underlying uncertainty is such that deviators cannot be identified by observing payoff realizations. This is done to emphasize the difference between the role of community enforcement on non-market actions and that of formal enforcement on formal markets.

Spot Credit Market Following, Shleifer and Wolfenzon (2002), Burkart, Panunzi, and Shleifer (2003), Burkart and Panunzi (2006), Burkart and Ellingsen (2004), and Balmaceda, Fischer, and Ramirez (2014), we assume that there is an ex-ante moral hazard. Namely, individuals may use (part of) the available resources (endowment and borrowed funds) to generate non-verifiable private benefits or they can be used for other projects that are not related to the ones here. In other words, they can engage in resource diversion. Market returns, however, are fully verifiable and therefore they can be pledged to outside investors, but investments are non-contractible. The return to non-market exchange is also verifiable, yet community members cannot require that they are verified in a court of law, but legal entities like banks can do so. This is done to emphasize the role of community sanctions on non-market actions rather than in all possible actions. Thus, individuals get the return of the investment only after honoring all repayment obligations and community members cannot use courts to punish a deviator in the non-market exchange. If all resources are diverted, no investment take place and nothing is repaid. For each dollar that an individual diverts, only a share ϕ of them is realized as private benefits. The rest is lost in the diversion process. Hence, we can interpret ϕ as the level of creditors protection, when $\phi = 0$ creditors are fully protected and any profitable investment would always possible. From here onwards, we will call ϕ the degree of credit protection or intensity of moral hazard. However, this should be interpreted more general as embodying the full justice system including the strength of property rights and laws, the monitoring ability of the legal system, and its enforcement of laws and property rights. Hence, incomplete creditor protection is the source of moral hazard in the credit market in our model.

To keep the analysis as simple as possible, we assume that the financial contract is a debt contract with repayment $r(\pi^i) = r^i$ in exchange for an amount of external funds D^i. We assume that investors compete in a Bertrand-like fashion for the right to finance investments. They, simultaneously, make take-it-or-leave-it offers to individuals and then they decide whether or not to accept the contract. We assume that contracts between investors and individuals are chosen simultaneously and, thus, financial contracts cannot be used as strategic commitment devices.[12] There is neither relationship-lending possibilities in this market nor savings options.

2.1 Discussion of Main Features of the Model

First, the model is a highly stylized model of a community whose main feature is that non-market exchange can only be sustained as an equilibrium outcome of a game that has a prisoners' Dilemma structure. Hence, non-market exchange is not the outcome of ascriptive characteristics of community members such as their trustworthiness, instead, it is the outcome of community members' enforcement which is possible due to the repeated interactions.[13] This definition of community or non-market exchange is consistent with the views of Coleman (1990) and Putnam (2000), for whom that implies the investment in non-contractible actions driven by self interest and enforced by means of community sanctions.

Second, the model abstracts away from savings in order to keep it as simple as possible and being able to keep the model within the realm of repeated games. If savings were allowed, the recursive structure of the model changes and becomes closely related to a consumption-savings model that makes the equilibrium analysis of the investment game more complicated without improving our understanding of the relation between market and non-market exchange and market-supporting institutions.

Third, we have assumed that the payoff from the non-market action is independent of the payoff from the market action. This is meant to avoid a mechanical relationship between the non-market action, the market action, and market-supporting institutions. However, as we will see, there will be an strategic relation between them that arises in the dynamic game.

Fourth, we assume that a deviation regarding the market action does not result in community sanctions such as community ostracism. This is meant to keep the market action as an anonymous market exchange enforced only by formal means, while the non-market action is enforced only by informal or community means.

[12] Equivalently, we could assume that they are not observable to other investors and firms.

[13] Balmaceda and Escobar (2017) study a similar game, under private information, which social network architectures result in higher levels of cooperation in a standard trust game. They show that an architecture of complete components is Pareto efficient.

3 Preliminary Results

3.1 Welfare Maximization

In this section, we study a benevolent central planner whose goal is to maximize welfare when non-market exchange is enforceable and there is moral hazard in the credit market. This is the best a community can achieve provided that there is moral hazard in the capital market. An alternative is welfare maximization in the absence of credit constraints or moral hazard. That outcome will be the same as the one that result when initial endowments are such that individuals are not credit constrained.

Let k_i be the non-divested resources. Then, the welfare-maximizing actions solve the following problem:

$$\max_{(x,y)\in\Re_+^{2n+2}} \Big\{ \sum_{i=1}^{n+1} \Big(\sum_{j\neq i} f(x_j, n) + g^i(y;\psi) + k_i - r_i - x_i - y_i \Big) \Big\} \qquad \text{SWC}$$

subject to

$$x_i + y_i \leq k_i,\ \forall i \in \mathcal{I}. \qquad \text{CC}$$

Let ξ_i be the Lagrange multiplier for the resource constraint in equation CC for individual i.

The first-order conditions and the complementary-slackness conditions for all $i \in \mathcal{I}$:

$$\begin{aligned} &x_i : nf_{x_i}(x_i;n) - 1 - \xi_i = 0,\\ &y_i : \sum_j g^j_{y_i}(y;\psi) - 1 - \xi_i = 0,\\ &\xi_i(x + y - k_i) = 0 \text{ and } \xi_i \geq 0. \end{aligned}$$

The main conclusion that follows from these first-order conditions is that the non-market and the market action are independent from each other whenever the resource constraint does not bind since actions are determined by $nf_{x_i}(x_i;n) - 1 = 0$ and $\sum_j g^j_{y_i}(y;\psi) - 1 = 0$. This implies that the welfare-maximizing market action fully internalizes the externalities and that market-supporting institution, as captured by ψ, have no impact on the non-market action when the resource constraint does not bind.[14] Let's denote the unique symmetric solution to these equations by (x^{fbu}, y^{fbu}).[15] In contrast, when the resource constraint binds, it is easy to show that the welfare-maximizing actions satisfy the following conditions: $x_i + y_i = k_i$ and $\sum_j g^j_{y_i}(y;\psi) = nf_{x_i}(x_i, n)$.[16] Hence, all the

[14]This will be the welfare-maximizing actions when there is no moral hazard since any project with positive net present value will be financed.

[15]The uniqueness follows from the strict concavity of the payoff functions.

[16]The uniqueness follows from the strict concavity of the payoff functions.

resources are spent and the marginal return to the non-market action is equalized to that of the market action when externalities are fully internalized. Let's denote the unique symmetric solution to these conditions by (x^{fbc}, y^{fbc}). Also let's define the income cutoff $k^{fb} \equiv \max\{0, x^{fbu} + y^{fbu}\}$ and let's denote the symmetric equilibrium in the investment sub-game by $(x(k), y(k))$. Hence, symmetry together with the dominant-diagonal property leads to the following result.

Lemma 1.

i) If $k \geq k^{fb}$, then $(x(k), y(k))$ is independent of k, $x(k)$ is independent of ψ, and $y(k)$ rises with ψ.

ii) If $k < k^{fb}$, then $(x(k), y(k))$ rises with (w, k), $x(k)$ falls with ψ and $y(k)$ rises with ψ.

When members are unconstrained, the market action rises with ψ since this makes marginal returns to y_i higher when externalities are taken into account. In contrast, when community members have limited resources to invest, the increases in the market action comes at the expenses of a decrease in the non-market action. Hence, in spite of the fact that market and non-market actions are payoff independent, they become substitutes in the investment sub-game when members are resource constrained.

Because lenders anticipate that individuals can divert with borrowed and their own funds, theylend them an amount that takes this into account. Given that the returns are certain and the diversion technology is such that it allows to enjoy a constant share of diverted resources as private benefits, diversion is an all-or-nothing decision. Hence, individuals prefer to invest the money than divert it whenever

$$\sum_{j \neq i} f(x_j(k), n) + g^i(y(k); \psi) + d_i + w - r_i - x_i(k) - y_i(k) \geq \phi\big(d_i + w\big). \tag{1}$$

Because the credit market is perfectly competitive, in equilibrium, lenders must make zero profits in each contract and thereby $d_i = r_i$. It readily follows from equation (1) that the maximum amount that investors can lend to individual i without inducing diversion is given by: $d_i = \phi^{-1}(\sum_{j \neq i} f(x_j(k), n) + g^i(y(k); \psi) + w - x_i(k) - y_i(k)) - w$, where $k_i = w + d_i$. Observe that the larger the payoffs from the non-market and market action, the larger the amount that an individual can borrow since a larger amount can be pledged to outside investors. Hence, any given community member will be able to undertake a larger market and non-market action.

The welfare-maximizing debt solves the following problem:

$$\max_{d \in \Re_+^{n+1}} \Big\{ \sum_{i=1}^{n+1} \Big(\sum_{j \neq i} f(x_j(k), n) + g^i(y(k); \psi) + w - x_i(k) - y_i(k) \Big) \Big\} \tag{SWC}$$

subject to

$$d_i \leq \phi^{-1}(\sum_{j \neq i} f(x_j(k), n) + g^i(y(k); \psi) + w - x_i(k) - y_i(k)) - w \tag{RCC}$$

Let's define the income threshold $w^{fbu}(\psi) \equiv x^{fbu} + y^{fbu}$. When income is higher than or equal to this threshold, the symmetric equilibrium is the unconstrained equilibrium, the actions are independent of the debt level and, therefore, the welfare-maximizing debt is zero. In contrast, when $w < w^{fbu}(\psi)$, there is an optimal debt and endowment level that ensure that $x^{fbu} + y^{fbu}$ is feasible.

To make the problem interesting, from here onwards, we will assume that if the endowment is zero, the severity of the moral hazard problem is such that individuals cannot borrow enough to choose the unconstrained investments; that is,

Assumption 1. $\phi > \phi^{fb} \equiv \frac{\sum_{j \neq i} f(x^{fbu}, n) + g^i(y^{fbu}; \psi)}{x^{fbu} + y^{fbu}} - 1.$

In this case, resource-constrained members borrow as much as possible and therefore the optimal debt is the highest debt level that solves the incentive-compatibility constraint in equation (RCCD) with equality. This entails $d = (1+\phi)^{-1}\big(nf(x(k), n) + g^i(y(k); \psi)\big) - \phi(1+\phi)^{-1}w$.

Lemma 2. *Suppose that Assumption 1 holds.*

i) There exits a unique positive debt level, denoted by $d^{fb}(\psi, \phi, w)$, that solves the credit constraint with equality. Furthermore, $d^{fb}(\phi, \psi, w)$ increases with (ψ, w) and decreases with ϕ.

ii) There exists a unique endowment level, denoted by $w^{fbc}(\phi, \psi)$, such that $w + d^{fbc}(\phi, \psi, w) < x^{fbu} + y^{seu}$ for all $w < w^{fbc}(\phi, \psi)$.

When the endowment is higher than or equal to $w^{fbc}(\psi, \phi)$, the symmetric equilibrium is the unconstrained equilibrium, the actions are independent of the debt level and, therefore, the welfare-maximzing debt is zero. When $w < w^{fbu}(\psi)$, but higher than $w^{fbc}(\phi, \psi)$, the symmetric equilibrium is also he unconstrained equilibrium, but in contrast to the preceding case, the optimal debt is positive and equal to the minimum debt required to finance the unconstrained welfare-maximizing equilibrium; that is, debt is equal to $d^{fb}(\psi, \phi) = dx^{fbu} + y^{fbu} - w$. Lastly but not least, when $w < w^{fbc}(\phi, \psi)$, the maximum incentive-compatible debt plus the endowment are not enough to finance the welfare-maximizing actions and thereby the symmetric equilibrium is the constrained equilibrium.

We deduce the next result from the preceding discussion.

Proposition 1. *Suppose that Assumption 1 holds.*

i) If $w \geq w^{fbc}(\phi,\psi)$, $(x^{fb}, y^{fb}) = (x^{fbu}, y^{fbu})$. x^{fb} is independent of (ϕ,ψ,w), y^{fb} increases with ψ, and is independent of (ϕ, w).

ii) If $w < w^{fbc}(\phi,\psi)$, $(x^{fb}, y^{fb}) = (x^{fbc}, y^{fbc})$. This falls with ϕ, rises with w, y^{fb} increases with ψ, and if $\big(g^i_\psi + (\sum_{j\neq i} g^i_j - (1+\phi^{fb}))y^{fbc}_\psi\big)|_{y^{fbc}} > 0$, there exists a threshold, denoted $\phi^{fb}(w,\psi)$, such that x^{fb} rises with ψ for all $\phi < \phi^{fb}(w,\psi)$.

iii) $w^{fb}(\psi,\phi)$ rises with ϕ and falls with ψ.

When the community is wealthy ($w \geq w^{fbc}(\phi,\psi)$), market-supporting institutions have no bearing on the non-market exchange since non-market payoffs are independent of ψ, while the market action rises with ψ since externalities are fully internalized and marginal returns increases with it. Capital-market institutions aimed at limiting moral hazard have no bearing on the equilibrium outcome since members do not borrow money. In contrast, when the community is poor, improvements in capital-market institutions result in larger actions since the community is able to borrow more. Better market-supporting institutions have an ambiguous effect. On one hand, an increase in ψ, holding resources constant, increases the market action and this crowds-out the non-market action. On the other hand, an increase in ψ softens, ceteris-paribus, the incentive-compatibility constraint regarding borrowing since the return to the market action rises and the return to diversion stays the same. Hence, there are more resources to invest in both the market and non-market action. The market action rises because the two effects reinforced each other, while they go in the opposite direction with regard to the non-market action. This implies that the non-market action rises when the increase in resources more than compensate the increase in the market action due to an improvement in market-supporting institutions. Because there is moral hazard in the credit market, this requires that the capital-market institutions are effective at curtailing it so that the pass-through from market returns to borrowing is large. Because when capital-market institutions worsen, the endowment threshold under which members are constrained increases, there is a change in the extensive margin in the sense that marginally unconstrained members become constrained. The same happens when market-supporting institutions worsen.

When $w \geq w^{fbc}(\phi,\psi)$, welfare is given by

$$W(\phi,\psi,w) = (n+1)(nf(x^{fbu};n) + g^i(y^{fbu};\psi) + w - y^{fbu} - x^{fbu}),$$

while when $w < w^{fbc}(\phi,\psi)$, this is given by

$$W(\phi,\psi,w) =(n+1)\phi(1+\phi)^{-1}\big(\big(f(w + d^{fb}(\phi,\psi,w) - y^{fbc};n) + g^i(y^{fbc};\psi) + w\big).$$

Proposition 2. *Suppose that Assumption 1 holds.* $W(\phi, \psi, w)$ *rises with* (ψ, w)*, and if* $w \geq w^{fbc}(\phi, \psi)$*, it is independent of* ϕ*, while if* $w < w^{fbc}(\phi, \psi)$*, it falls with it otherwise.*

Hence, improving market-supporting improve welfare, and improving capital-market institutions increases welfare when the community is resource constraint because diversion becomes less attractive, which softens the incentive-compatibility constraint regarding borrowing, and lowers the initial endowment threshol above which members are unconstrained.

3.2 The Static Equilibrium

The static equilibrium is key since we will focus on grim-trigger strategies that switch to play the static equilibrium after a deviation is observed.

Provided that individual i's available resources are k_i and other members of the community will choose y_{-i}, he will solve the following problem

$$\max_{(y_i,x_i)\in\Re^2_+} \Big\{ \sum_{j\neq i} f(x_j, n) + g^i(y;\psi) + w - x_i - y_i \Big\} \text{ subject to } y_i \leq k_i.$$

Because each community member's benefit from the non-market action is independent of his own action, it is optimal not to participate in non-market exchange. It readily follows from this that agent i's best-response function, denoted by $BR^u(y_{-i})$, is the unique solution to $g^i_{y_i}(y;\psi) - 1 = 0$ when $BR^u(y_{-i}) \leq k_i$; otherwise, it is given by k^i and denoted by $BR^c(y_{-i})$. If members are identical, in the symmetric equilibrium, the non-market action profile is $x = 0$ and the market action is the unique solution to $g^i_{y_i}(y;\psi) - 1 = 0$ for all $i \in \mathcal{I}$. Let's denote this by y^{seu} and define $k^{se} \equiv y^{seu}$. If $k^i \geq k^{se}$, then the unique equilibrium entails $y(k) = y^{seu}$; otherwise, the unique symmetric equilibrium is given by $y^{sec} = k$. Let's denote the equilibrium market action in the investment sub-game $y(k) \equiv \min\{y^{sec}, k\}$ and notice that it is weakly increasing in (k, ψ). Because $g^i_{y_i\psi} > 0$, when market actions are strategic complements, this follows from the monotone comparative statics results in Milgrom and Roberts (1990), while when they are strategic substitutes, this follows from symmetry and the dominant-diagonal property. Symmetry ensures that the increase in every best response is the same for all members and therefore the direct effect dominates the indirect effects.[17]

Let $(x(k), y(k))$ be the equilibrium in the investment sub-game when resource profile is k.

Proposition 3. *If* $k \geq k^{se}$*, then* $x(k) = 0$*,* $y(k) = y^{seu}$ *rises with* ψ *and is independent of* k*, while if* $k < k^{se}$*, then* $x(k) = 0$ *and* $y(k) = k$ *rises with* k *and independent of* ψ*.*

Because lenders anticipate that individuals can divert with borrowed and their own funds, they must lend them an amount that does not induce them to divert. For the same reasons already given,

[17] We can weaken the dominant-diagonal assumption by assuming that the Jacobian of the first-order conditions is B-matrix.

diversion is an all-or-nothing decision. Hence, individuals prefer to invest the money than diverting with it whenever

$$g^i(y(k);\psi) + d_i + w - r_i - x_i(k) - y_i(k) \geq \phi\big(d_i + w\big), \tag{2}$$

Because the credit market is perfectly competitive, in equilibrium, lenders must make zero profits in each contract and thereby $d_i = r_i$. It readily follows from equation (2) that the maximum amount that investors can lend to individual i without inducing diversion is given by: $d_i = \phi^{-1}(g^i(y(k);\psi) + w - y_i(k)) - w$, where $k_i = w + d_i$. Observe that the larger the payoff to the market action, the larger the amount that an individual can borrow since he can pay back a larger amount to outside investors. This implies that when he is constrained, he will be able to undertake a larger market action.

Provided that other members choose $y_{-i}(k)$, member i solves the following problem[18],

$$\begin{aligned}
&\max_{k_i \in \Re_+} \{g^i(y(k);\psi) + w - y_i(k)\} \\
&\text{subject to} \\
&d_i \leq \phi^{-1}(g^i(y(k);\psi) + w - y_i(k)) - w.
\end{aligned}$$

It readily follows from this that in the symmetric equilibrium if $k \geq y^{seu}$, the optimal debt is zero, while if $y^{seu} < k$, they will borrow money and the maximum that they can borrow in the symmetric equilibrium is the solution to the equation $d = (1+\phi)^{-1}g^i(w+d,\dots,w+d;\psi) - (1+\phi)^{-1}\phi w$. Let's denote its solution by $d^{se}(\phi,\psi,w)$.

To make the problem interesting, from here onwards, we will assume that if the endowment is zero, the severity of the moral hazard problem is such that individuals cannot borrow enough to choose the unconstrained investments; that is,

Assumption 2. $\phi > \phi^{se} \equiv \frac{g^i(y^{seu};\psi)}{y^{seu}} - 1$.

Lemma 3. *Suppose Assumption 2 holds.*

i) $d^{se}(\phi,\psi,w)$ *is unique, increases with* ψ*, decreases with* ϕ*, and increases with* w *whenever* $\sum_j g^i_{y_j}(y(k);\psi) > \phi$.

ii) There exists a unique endowment level, denoted by $w^{se}(\phi,\psi)$*, such that* $w + d^{se}(\phi,\psi,w) < y^{seu}$ *for all* $w < w^{se}(\phi,\psi)$.

iii) $w^{se}(\phi,\psi)$ *rises with* ϕ *and, if* $\big(y^{seu}_\psi(1+\phi-\sum_j g^i_j) + g^i_\psi\big)|_{y^{seu}}$*, rises with* ψ.

[18] We assume that individuals borrow the minimum required to finance their investment since there is no benefit of borrowing more.

This lemma shows that the maximum that a community member can borrow in a symmetric equilibrium rises with the quality of market-supporting institutions since a higher ψ rises the payoff from the market action and the market action profile is independent of ψ when members are income constrained in the action sub-game. An increase in ϕ lowers the maximum that can be borrowed since the intensity of moral hazard is higher and therefore borrowers' temptation to divert is higher. A larger endowment rises the debt limit when an equal increase in each market action results in that the market-action payoff rises more than ϕ, which is the benefit from diversion. This is always the case when externalities are non-negative due to the fact that members are constrained and therefore $g_i^i(\cdot) > 1 > \phi$; otherwise, this is the case when externalities are not too negative.

From the results and discussion above, we deduce the following.

Proposition 4. *Suppose Assumption 2 holds.*

i) If $w \geq w^{se}(\phi, \psi)$, $(x^{se}, y^{se}) = (0, y^{seu})$ and y^{seu} increases with ψ and is independent of (ϕ, w)

ii) If $w < w^{se}(\phi, \psi)$, $(x^{se}, y^{se}) = (0, y^{sec})$ and $y^{sec} = w + d^{se}(\phi, \psi, w)$ increases with (ψ, w) and falls with ϕ.

We conclude from this and Proposition 1 that there are two inefficiencies: first, the non-market action is zero since everyone anticipates that no one else will invest in the non-market action, while the welfare-maximizing non-market action is positive. Hence, there is an extreme form of underinvestment in the non-market action. Second, the market action is inefficiently small when externalities are positive and inefficiently large when externalities are negative since community members do not internalize externalities, while those are fully internalized in the welfare-maximizing equilibrium.

If $w \geq w^{se}(\phi, \psi)$, the static equilibrium payoff is given by $V(\phi, \psi, w) = g^i(y^{seu}; \psi) + w - y^{seu}$ and if $w < w^{se}(\phi, \psi)$, this is given by $V(\phi, \psi, w) = (1 + \phi)^{-1}\phi(g^i(w + d^{se}(\phi, \psi, w); \psi) + w)$. Then, we have the following result.

Proposition 5. *Suppose Assumption 2 holds.*

i) If $w \geq w^{se}(\phi, \psi)$, $V_w(\phi, \psi, w) = 1$, while if $w < w^{se}(\phi, \psi)$, $V_w(\phi, \psi, w) \in (0, 1)$.

ii) If $w \geq w^{se}(\phi, \psi)$, $V_\psi(\phi, \psi, w) > 0$ if and only if $g_\psi^i \sum_j g_{y_i y_j}^i(y^{seu}; \psi) - g_{y_i \psi}^i \sum_{j \neq i} g_{y_j}^i(y^{seu}; \psi) \leq 0$, while if $w < w^{se}(\phi, \psi)$, $V_\psi(\phi, \psi, w) > 0$.

iii) If $w \geq w^{se}(\phi, \psi)$, $V_\phi(\phi, \psi, w) = 0$, while if $w < w^{se}(\phi, \psi)$, $V_\phi(\phi, \psi, w) > 0$ if and only if $\sum_j g_{y_j}^i(y(d^{se}); \psi) < 1$.

When individuals are wealthy, the equilibrium payoff increases with w because the market-action is independent of w, and when they are not, it rises because debt falls with the endowment at a rate lower than 1 and therefore as w rises member are able to borrow more. An increase in ψ rises the market payoff when actions are held constant and may either increase or decrease the equilibrium market action. When members are wealthy, the payoff increases when the direct effect dominates the payoff change due to the changes in equilibrium actions. This is always the case when externalities are positive, while it might not be the case when externalities are negative. The equilibrium payoff of poor community members rises with ψ since the direct impact on the market payoff dominates the absolute value of the change in the market payoff due to the change in equilibrium debt since the pass-trough from returns to debt is lower than one. An increase in the intensity of moral hazard does not affect rich community members' payoff since they do not borrow money and increases that for poor members when debt does not increase too rapidly with ϕ. This stems from the fact that a higher ϕ implies a lower debt which increases the payoff when $\sum_j g^i_{y_j}(y(d^{se});\psi) < 0$, but also implies, holding actions constant, a higher expected payoff since in the case of default, the members are either less likely to get caught or enjoy larger private benefits or both. Hence, in the static equilibrium the impact of a change in a market-supporting institutions (ϕ, ψ) on the value function is non-monotone and the sign of the relationship depends on whether the community is wealthy or not and the size of the uninternalized externalities. Better capital-market institutions also lower the threshold for a community to be constrained and improvement in market-supporting institutions do so when y^{se}_{ψ} is no too negative.

4 The Dynamic Equilibrium

4.1 The Equilibrium

Here, we consider the repeated game where the static game is played repeatedly forever and community members play grim-trigger strategies that switch to play the static equilibrium indefinitely after a deviation regarding non-market actions is observed.[19]

When individuals play grim-trigger strategies, each member's investment in the non-market action $x_i \in \Re_+$ is incentive-compatible in each period, provided that he invests $y_i \in \Re_+$ in the market action, and the investment profile is (x, y) if and only if x_i is such that member i prefers x_i and than investing zero. Hence, the following must be satisfied:

$$\begin{aligned}&\sum_{j \neq i} f(x_j, n) + g^i(y;\psi) + d_i + w - r_i - x_i - y_i \geq \\ &(1-\delta)\big(\sum_{j \neq i} f(x_j, n) + g^i(y;\psi) + d_i + w - r_i - y_i\big) + \delta V_i(\phi, \psi, w),\end{aligned} \tag{3}$$

where $V_i(\phi, \psi, w)$ is the equilibrium payoff of the one-shot game.

[19] This is optimal in our setting since there is perfect monitoring. See, Wolitzky (2013).

Because the capital market is perfectly competitive $r_i = d_i$, the incentive constraint for the non-market action in equation (3) re-writes as follows:

$$x_i \leq \delta\Big(\sum_{j\neq i} f(x_j;n) + g^i(y;\psi) + w - y_i - V_i(\phi,\psi,w)\Big). \tag{4}$$

It readily follows from the incentive constraint that the punishment is to lose the payoff from participating in non-market exchange and the benefit is to save the cost of investing in the non-market action and to obtain the payoff from the static equilibrium forever thereafter.[20] An increase in the static-game equilibrium payoff crowds out incentives to invest in the non-market action since deviations are more tempting. Proposition 5 provides conditions under which the quality of market-supporting policies increase the payoff from the static equilibrium and thereby this results in a crowding out of the incentives to invest in non-market exchange.

Let's define $x(\delta, y)$ as the largest solution to the incentive constraint in equation (4) when this exists, otherwise $x(\delta, y)$ is set to zero. Also, let's define $\delta^u(\phi,\psi,w)$ as the lowest discount factor such that $x^{fbu} = x(\delta, y^{seu})$. Then, we have the following result.

Lemma 4. *For any (y, w, ψ), there exists a threshold $V_i(\delta)$ such that $x(\delta, y)$ exists for all $V_i(\phi,\psi,w) < V_i(\delta)$, $x(\delta, y)$ increases with δ, increases with y for all $y_i \leq y^{seu}$, and rises with w when $w \geq w^{fb}$; otherwise, it rises whenever $\sum_i g^i_{y_i}(y(d);\psi)\big|_{y=w+d^{se}} \leq 0$. There exits a unique and positive discount factor, denoted by $\delta^u(\phi,\psi,w)$, such that $x(\delta, y^{seu}) \geq x^{fbu}$ for all $\delta \geq \delta^u(\phi,\psi,w)$.*

Hence, for any y, the largest self-sustainable non-market action is positive if and only if the equilibrium payoff in the static game is sufficiently small; otherwise, a positive non-market action is not self-sustainable. Furthermore, whenever the static-equilibrium market action is implemented, there exists a discount factor such that the welfare-maximizing non-market action is implementable.

As it is the case in most repeated games, there are multiple equilibrium, among which the repetition of the static equilibrium is one of them, the welfare-maximizing equilibrium and the Pareto dominant equilibrium are others.[21] We, however, adopt a different selection criteria which is less demanding in terms of individuals' coordination. Namely, members select the equilibrium that implements the market action that maximizes their individual payoff and the minimum between the largest self-sustainable non-market action $x(\delta, y)$ and the welfare-maximizing non-market action x^{fbu} provided that it is feasible; i.e., there is enough income to finance it.[22] We view this as more

[20] Provided that market actions cannot be enforced by community punishments, this is the worst possible punishment.

[21] For instance, Balmaceda and Escobar (2017) study both the welfare and Pareto in a repeated network game, Wolitzky (2013) studies the welfare-maximizing strategy profile in a repeated network game, and Gagnon and Goyal (2017) study the Pareto equilibrium of a static network game. The collusion literature focuses mainly on sustaining the highest possible price, which is the monopoly price, and it is the welfare-maximizing equilibrium when welfare is defined as the sum of firms' profits (players' payoffs).

[22] All equilibrium selection criteria have weakness in some dimensions and are debatable, yet the chosen one is consistent with the individuals' behavior in the one-shot game.

appropriate criteria for the problem at hand than the welfare-maximizing criteria, where market externalities are fully internalized, because this goes against the notion of anonymous markets. In addition, our selection criteria provides the most adverse case for complementarity between the market and non-market exchange since the crowding out effect is stronger, and exacerbates the distinction between market and non-market exchange by considering that market exchange will be enforced only by formal institutions, while non-market exchange can be enforced only through community enforcement. So, we can think of this as a selection criteria robust to community enforcement in the sense that people considers non-market exchange only when they have already taken advantage of the benefits of formal enforcement, which is a key advantage of market exchange.

Let's define the set

$$X(\delta, y, k_i) \equiv \Big\{x_i \in \Re_+ | x_i = \min\big\{x^{fbu}, x(\delta, y)\big\} \text{ if } \min\big\{x^{fbu}, x(\delta, y)\big\} \leq k_i - y_i \text{ and }$$
$$x_i = \max\{k_i - y_i, 0\} \text{ otherwise}\Big\}.$$

Hence, under our equilibrium-selection criteria, member i will solve

$$\max_{(x_i, y_i) \in \Re_+^2} \Big\{\sum_{j \neq i} f(x_j, n) + g^i(y; \psi) + w - y_i - x_i\Big\} \tag{UMD}$$

subject to

$$x_i = X(\delta, y, d_i), \tag{ICCD}$$

$$y_i \leq k_i. \tag{CCD}$$

Provided that other members choose (x_{-i}, y_{-i}), member i wishes to take the market action that maximizes the per-period market payoff $g^i(y; \psi) + w - y_i$, which is y^{seu}, and to invest the surplus into the non-market action up maximum between the self-sustainable and the welfare-maximizing investment. Namely, when member i's non-diverted resources k_i are sufficiently large, he will choose y^{seu} and the minimum between the welfare-maximizing and the largest self-sustainable non-market action, which is the former whenever $\delta \geq \delta^u(\phi, \psi, w)$. When members do not have enough resources to implement this solution, they will spend them in the market action that maximizes the per-period market payoff and the remaining income will be spent, to extend that is incentive-compatible, on the non-market action. When resource is even lower, the investment in the market action will exhaust all them.

Let's define $x^{deu}(\delta) \equiv x(\delta, y^{seu})$, $k^u(\delta) \equiv y^{seu} + \min\{x^{fbu}, x^{deu}(\delta)\}$, and $k^c \equiv y^{seu}$. The preceding discussion leads to the following result.

Proposition 6.

i) There is a unique symmetric equilibrium given by

$$(x(k), y(k)) = \begin{cases} (\min\{x^{fbu}, x^{deu}(\delta)\}, y^{seu}) & \text{if } k \geq k^u(\delta), \\ (k - y^{seu}, y^{seu}) & \text{if } k \in [k^c, k^u(\delta)), \\ (0, k) & \text{if } k < k^c. \end{cases}$$

ii) $x(k)$ is non-decreasing in k.

Hence, in the dynamic setting, conditional on income, the market action chosen is inefficient since when choosing this action, members do not internalize strategic externalities. There is another inefficiency which is the underinvestment in the non-market action that results either from the incentive constraint or resource constraint or both. The former arises when the resource constraint does not bind, but the discount factor is sufficiently small so that the welfare-maximizing non-market action is larger than the maximum self-sustainable non-market action. The latter arises when the surplus after investing in the market action is insufficient to finance the welfare-maximizing non-market action in spite of the fact that this might be lower than the largest self-sustainable non-market action.

Because lenders anticipate that individuals can divert with the funds before investing, they limit borrowing capacity so that is incentive compatible. Given that the returns are certain and the diversion technology is such that it allows to enjoy a constant share of diverted resources as private benefits, diversion is an all-or-nothing decision, individuals prefer to invest the money than divert with it whenever

$$\sum_{j \neq i} f(x_j(k), n) + g^i(y(k); \psi) + d_i + w - r_i - x_i(k) - y_i(k) \geq \phi\big(d_i + w\big), \tag{5}$$

Given that the credit market is perfectly competitive, in equilibrium, lenders must make zero profits in each contract and thereby $d_i = r_i$. It readily follows from equation (5) that the maximum amount that investors can lend to individual i without inducing diversion is given by: $d_i = \phi^{-1}(\sum_{j \neq i} f(x_j(k), n) + g^i(y(k); \psi) + w - x_i(k) - y_i(k)) - w$, where $k_i = w + d_i$. Observe that the larger the payoffs from the non-market and market action, the larger the amount that can be borrowed since the payoff that can be pledged to outside investors is larger. Hence, any given community member will be able to undertake a larger market and non-market action if he so chooses. This means that sustaining a positive non-market action has an indirect benefit, which is to increase pledgable resources, and thereby the amount available to invest in both actions.

Community members anticipate the equilibrium of the game that will be played in the action sub-game and thereby they choose debt to maximize their expected payoff subject to the resources constraint; that is,

$$\max_{d^{se}\in\Re_+}\Big\{\sum_{j\neq i} f(x_j(k);n)+g^i(y(k);\psi)+w-x_i(k)-y_i(k)\big)\Big\} \qquad \text{UMD}$$

subject to

$$d_i \le \phi^{-1}(\sum_{j\neq i} f(x_j(k),n)+g^i(y(k);\psi)+w-x_i(k)-y_i(k))-w \qquad \text{RCCD}$$

The key to the solution to this problem is the behavior of equilibrium actions with respect to d. Rich community members (that is, $k \ge k^u(\delta)$ can finance the static equilibrium market action and the minimum between the welfare-maximizing and the largest self-sustainable non-market action with their own resources and, because there is no other benefit from borrowing different from financing actions, they do not borrow any money. When resources are not large enough to do so, members either borrow just enough to finance the static-equilibrium market action and the minimum between the welfare-maximizing and the largest self-sustainable non-market action, or they borrow as much as possible.

Because $x_i(k)+y_i(k)$ is independent of d whenever $k \ge k^u(\delta)$ and non-decreasing in d otherwise, the resource constraint in equation (RCCD) binds whenever $k < k^u(\delta)$.

From here onwards, we will assume that if the endowment is zero the severity of the moral hazard problem is such that individuals cannot borrow enough to choose the unconstrained –by resources– investments; that is,

Assumption 3. $\phi > \phi^{de} \equiv \frac{\sum_{j\neq i} f(x^{deu}(\delta),n)+g^i(y^{seu};\psi)}{x^{deu}(\delta)+y^{seu}} - 1.$

Let's define $d^{deu}(\psi,w,\delta)$ as $\min\{x^{fbu},x^{deu}(\delta)\}+y^{seu})-w$. Hence, whenever the incentive compatible debt is lower than $d^{deu}(\psi,w,\delta)$, the individual cannot invest $y^{seu}+\min\{x^{fbu},x(\delta,y^{seu})\}$. In this case, community members borrow as much as possible and therefore the optimal debt is the highest debt level that solves the incentive-compatibility constraint regarding borrowing with equality. This entails $d=(1+\phi)^{-1}\big(nf(x(k),n)+g^i(y(k);\psi)\big)-\phi(1+\phi)^{-1}w$.

Lemma 5. *Suppose that Assumption 3 holds.*

i) There exits a unique positive endowment level, denoted by $w^{deu}(\phi,\psi,\delta)$, such that the incentive-compatible debt is greater than or equal to $d^{deu}(\psi,w,\delta)$. Furthermore, $w^{deu}(\phi,\psi,\delta)$ increases with (δ,ψ,ϕ).

ii) There exits a unique positive debt level, denoted by $d^{dec}(\phi,\psi,w,\delta)$, that solves the credit constraint with equality. Furthermore, $d^{dec}(\phi,\psi,w,\delta)$, increases with ψ, decreases with ϕ, and when $w+d^{dec}(\phi,\psi,w,\delta)\ge y^{seu}$ increases with w, while $w+d^{dec}(\phi,\psi,w,\delta)<y^{seu}$, increases with w whenever $\sum_j g^i_j(y(k);\psi)>\phi$.

iii) There exists a unique endowment level, denoted by $w^{dec}(\phi,\psi)$, such that $w+d^{dec}(\phi,\psi,w) < y^{seu}$ for all $w < w^{dec}(\phi,\psi,w)$.

Because $d^{dec}(\phi,\psi,w) = d^{se}(\phi,\psi,w)$, since $x(k) = 0$, we deduce the next result from this and Proposition (7).

Proposition 7. *The equilibrium profile regarding the market and non-market action is given by:*

$$(x^{de}, y^{de}) = \begin{cases} (\min\{x^{fbu}, x^{deu}(\delta)\}, y^{seu}) & \text{if } w \geq w^{deu}(\phi,\psi,\delta), \\ w + d^{dec}(\phi,\psi,w,\delta) - y^{seu}, y^{seu}) & \text{if } w^{dec}(\phi,\psi,\delta) \leq w < w^{deu}(\phi,\psi,\delta), \\ (0, w + d^{se}(\phi,\psi,w)) & \text{if } w < w^{dec}(\phi,\psi,\delta). \end{cases}$$

When initial endowments are large, communities are able to implement the social-welfare maximizing non-market action when they are sufficiently patient so that this is lower than the largest self-sustainable non-market action; that is, $\delta \geq \delta^{deu}(\phi,\psi,w)$; otherwise, they choose the largest self-sustainable non-market action. In both cases they have enough resources to choose the market action that maximizes their payoff. In this case, the equilibrium is inefficient because members do not internalize the strategic market externalities and thereby they overinvest in the market action when externalities are negative and underinvest in it otherwise. There is a second inefficiency, which is to invest too little in the non-market action when the discount factor is such that $\delta < \delta^{deu}(\phi,\psi,w)$. However, the underinvestment is much less severe than in the static equilibrium where the non-market action is zero. So, highly-endowed communities partially or fully solve the inefficiency due to underinvestment in the non-market action that arises in the static setting but, as in the static case, the inefficiency in the market action cannot be solved since strategic spot markets do not allow for community punishments.[23]

When initial endowments are neither large nor small, community members are constrained in their ability to raise external funds to implement the static-equilibrium market action plus the minimum between the welfare-maximizing non-market action and the largest self-sustainable non-market action. In this case, the lack of resources results in that the market action crowds out the non-market action and therefore the underinvestment inefficiency in the non-market action is exacerbated, yet they still invest resources in it and therefore the improve upon the static equilibrium.

When initial endowments are small, the non-market action is fully crowded-out by the market action since the endowment is so small that together with the maximum incentive-compatible debt is not enough to finance y^{seu}. Hence, the dynamic inefficiencies are identical to the static inefficiencies. This implies that in the equilibrium selected, the set of options faced by poor communities is not enlarged when dynamic punishments are feasible.[24]

[23] In the next section/ bm3, we will discuss the consequences of allowing community punishments for market actions.

[24] As we will discuss latter, this would not happen if we were to use the welfare-maximizing equilibrium selection criteria.

When $w \geq w^{deu}(\phi, \psi, \delta)$, the dynamic-equilibrium payoff is given by

$$V(\phi, \psi, w, \delta) = nf(\min\{x^{fbu}, x^{deu}(\delta)\}; n) + g^i(y^{seu}; \psi) + w - y^{seu} - \min\{x^{fbu}, x^{deu}(\delta)\};$$

when if $w^{dec}(\phi, \psi, \delta) \leq w < w^{deu}(\phi, \psi, \delta)$ is given by

$$V(\phi, \psi, w, \delta) =(1 + \phi)^{-1}\phi\big(nf(w + d^{dec}(\phi, \psi, w, \delta)) - y^{seu}; n) + g^i(y^{seu}; \psi) + w\big);$$

and when $w < w^{dec}(\phi, \psi, \delta)$ is given by

$$V(\phi, \psi, w, \delta) =(1 + \phi)^{-1}\phi(g^i(w + d^{se}(\phi, \psi, w); \psi) + w).$$

Then, we have the following result.

Proposition 8. *For communities with an initial endowment larger than $w^{dec}(\phi, \psi, \delta)$, $V(\phi, \psi, w, \delta) > V(\phi, \psi, w)$, while for communities with an initial endowment smaller than or equal to $w^{dec}(\phi, \psi, \delta)$, $V(\phi, \psi, w, \delta) = V(\phi, \psi, w)$.*

Hence, welfare in the dynamic equilibrium is larger than in the static equilibrium because it is possible to induce non-market participation, except when the initial endowment is small so that members cannot borrow enough to scape to invest everything on market exchange.

5 Dynamic Equilibrium: The Role of Market-Supporting Institutions

5.1 When Are Market and Non-Market Exchange Complements?

In this sub-section, we ask whether improvements in market-supporting institutions increase both market and non-market action or increase the market action and decrease the non-market action. In other words, whether market and non-market action are either complements or substitutes. We have already shown that when the endowment is small, market exchange fully crowds out non-market exchange. But when the resources are such that no full crowding out takes place, the question posed above is a pertinent one.

Proposition 9. *Suppose that $w \geq w^{deu}(\phi, \psi, \delta)$. For any δ, (x^{de}, y^{de}) is independent of ϕ, x^{de} is independent of ψ, rises with w, and rises with δ when $\delta < \delta^u(\phi, \psi, w)$, and y^{de} is independent of w, and rises with ψ if and only if*

$$\Big(g^i_\psi(y; \psi) - \frac{g^i_{y_i\psi}(y; \psi)}{\sum_j g^i_{y_i y_j}(y; \psi)} \sum_{j \neq i} g^i_{y_j}(y; \psi)\Big)\Big|_{y^{seu}} < 0.$$

When the initial endowment is large (i.e., $w \geq w^{deu}(\phi, \psi, \delta)$) and community members place a high weight on the future; that is, $\delta \geq \delta^u(\phi, \psi, w)$, the static equilibrium market action is chosen and the non-market action is the welfare-maximizing one and thereby the non-market action is independent of the market action and the market-supporting institutions (ϕ, ψ), while in rich communities where community members are not as patient, the equilibrium non-market action is the largest self-sustainable non-market action and thereby this could in principle depend on the market-action level as well as the market-supporting institutions. However, because $w^{deu}(\phi, \psi, \delta) > w^{se}(\phi, \psi)$, the payoff from market exchange in the dynamic equilibrium; $g^i(y^{seu}; \psi) - y^{seu}$ is identical to the payoff in the static equilibrium $V(\phi, \psi, w)$, which is the payoff during the punishment face. Hence, the non-market action's incentive compatibility constraint is independent of ψ and so does x^de Because the dynamic equilibrium is selected is such that the market action maximize the individual payoff, the market action rises with ψ when the market payoff $g^i(y^{seu}; \psi) - y^{seu}$ rises with ψ, which depends on the size of the uninternalized externalities. Hence, in communities where resources are abundant improving market-supporting institutions neither crowds-our nor rises the non-market action.

Proposition 10. *If $w^{dec}(\phi, \psi, \delta) \leq w < w^{deu}(\phi, \psi, \delta)$.*

i) y^{de} rises with ψ and is independent of (ϕ, w, δ).

ii) x^{de} falls with ϕ, rises with w, and if $g^i_\psi + (\sum_{j \neq i} g^i_j - (1 + \phi^{de}))y^{seu}_\psi > 0$, then there exists a threshold $\hat{\phi}^{de}$ such that $x^{de}_\psi > 0$ if and only if $\hat{\phi} < \psi^{de}$.

When resources are neither large nor small and members are sufficiently patient, the equilibrium market action rises with ψ and is independent of (ϕ, w, δ) and the non-market action rises with w, falls with ϕ, and it is independent of δ. This stems from the fact that their income does not allow them borrow enough to finance the static-market action and the minimum between the welfare-maximizing and the largest self-sustainable non-market action. Hence, the non-market action is equal to the income plus debt minus the market action. This plus the fact that debt falls with ϕ and total resources plus debt rises with w explain the result. An improvement in the market-supporting institutions increases the market action, which holding the income plus debt constant, implies a lower non-market action. Because in equilibrium, better market-supporting institutions result, holding y constant, in a larger market-action payoff, pledgable income is higher and thereby borrowing capacity is larger. This results in a larger non-market action. When the trade-off between these two forces is resolved in favor of an increase in borrowing capacity larger than the increase in the market action, the non-market action rises. This occurs when capital-market institutions are able to keep the intensity of moral hazard low; i.e., small θ and externalities are not too negative since this implies that the pass-through from ψ to borrowing capacity is large and the gain in borrowing capacity is not spent entirely in the market action.

Proposition 11. *If $w < w^{dec}(\phi, \psi, \delta)$, then $x^{de} = 0$ and y^{de} decreases with ϕ, rises with (ψ, w), and is independent of δ.*

When initial endowments are small, members' borrowing capacity is not enough to participate in both market and non-market exchange so that they exclude themselves from the latter and invest everything in the market action. Because members are financially constrained, the market action falls with ϕ since the more intense is the moral hazard problem in the capital market, the less smaller is the borrowing capacity, increases with w and ψ. The former is due to the fact that the pass-trough from w to debt is higher than -1 and the latter is due to rise in borrowing capacity since the payoff from the market action rises with ψi.

5.2 Welfare

First, we study the behavior of the equilibrium actions with respect to (ϕ, ψ, w, δ) and then we study the optimality of institutions.

Proposition 12.

i) *If $w \geq w^{deu}(\phi, \psi, \delta)$, $V(\phi, \psi, w, \delta)$ is non-decreasing with (δ, w), independent of ϕ, and if $\delta \geq \delta^u(\phi, \psi, w)$, $V(\phi, \psi, w, \delta)$ is increasing in ψ, while if $\delta < \delta^u(\phi, \psi, w)$, it is increasing if and only if*

$$\Big(g^i_\psi + (\sum_j g^i_{y_j} - 1)y^{seu}_\psi\Big)\big|_{(x^{de}, y^{de})} > 0.$$

ii) *If $w^{dec}(\phi, \psi, \delta) \leq w < w^{deu}(\phi, \psi, \delta)$, $V(\phi, \psi, w, \delta)$ rises with w, falls with ϕ, and rises with ψ if and only if*

$$\Big(g^i_\psi + (\sum_j g^i_{y_j} - nf_{x_i})y^{seu}_\psi\Big)\big|_{(w+d^{dec}-y^{seu}, y^{seu})} > 0.$$

iii) *If $w < w^{de}(\phi, \psi)$, $V(\phi, \psi, w, \delta)$ rises with (w, ψ) and increases with ϕ if and only if $\sum_j g^i_{y_j}(y; \psi)\big|_{w+d^{se}(\phi,\psi)} < 1$.*

5.3 The Optimal Market-supporting Institutions

We now characterize the welfare-maximizing quality level of market-supporting institutions ψ and capital-market institutions ϕ.

Let $C(\psi, \phi) : \Re_+ \times [0, 1] \to \Re$ be the (per-capita) cost of supporting the institutional quality (ψ, ϕ). We assume that C is increasing in ψ and decreasing in ϕ and quasi-convex in (ψ, ϕ), so a larger legal or formal institutional setting is needed to punish people who engage in diversion and in regulation that make formal markets work more efficiently such as lifting distortionary taxes, lowering entry cost, eliminating red tape, etc... We assume that C is differentiable in both arguments, but only when $\psi > 0$ or $\phi > 0$ or both. This is done to allow for a discontinuity at $(\psi, \phi) = 0$, so that there can be a fixed cost that kicks in for positive enforcement. Hence, the benevolent central planner solves the followign problem

$$\max_{(\phi,\psi)\in\Re_+\times[0,1]} \{V(\phi, \psi, w, \delta) - C(\psi, -\phi)\}.$$

Let's denote the solution to the central planer's problem by (ψ^{de}, ϕ^{de}). The following result readily follows from Proposition 12.

Proposition 13.

i) If $w \geq w^{deu}(\phi, \psi, \delta)$, then $\phi^{de} = 1$ and $\psi^{de} > 0$ if $(g^i_\psi + (\sum_j g^i_{y_j} - 1)y^{seu}_\psi)|_{y=y^{seu}} > 0$.

ii) If $w^{dec}(\phi, \psi, \delta) \leq w < w^{deu}(\phi, \psi, \delta)$, then $\phi^{de} > 0$ and $\psi^{de} > 0$ if $(g^i_\psi + (\sum_j g^i_{y_j} - nf_i)y^{seu}_\psi)|_{(w+d^{dec}-y^{seu}, y^{seu})} > 0$.

iii) If $w < w^{de}(\phi, \psi)$, then $\psi^{de} > 0$, and if $\sum_j g^i_{y_j}(y; \psi)\big|_{w+d^{se}(0,\psi)} < 1$, $\phi^{de} > 0$.

When communities rely on credit to implement their desired allocation, be that to invest the utility-maximizing amount or any other amount, it is worthwhile to invest in capital-market supporting institutions such as creditors' protection, property rights, the quality of the legal system, etc... In contrast, when initial endowments are such communities can implement the utility-maximizing actions without need of credit, it is unnecessary to invest in improving the institutions that regulate the working of the capital market. With regard to market supporting institutions, it is welfare-maximizing to invest in them since they members are cash-constrained in the investment sub-game and thereby better market-supporting institutions rise the borrowing capacity and, as a result, the market action. When the initial endowment is such that members choose to participate in non-marker exchange, investing in improving the quality of market-supporting institutions increase welfare only when the market payoff $g(y^{seu}; \psi) - y^{seu}$ increases with it since this not only rises this payoff but also the borrowing capacity. This demand that that uninternalized externalities not to be too negative.

6 Discussion

In this section, we discuss the robustness of our result. First, we could have assumed the welfare-maximizing equilibrium selection criteria instead of our criteria. However, doing so will not change the main result regarding the conditions under which market and non-market exchange are complements/substitutes, but it will change the equilibrium inefficiencies. The equilibrium action profile will be different for two reasons: first, externalities in market actions will be fully internalized; and second, the allocation of resources between non-market and market action will be driven by the equalization of marginal returns across actions; that is, for all i, the equilibrium allocation will satisfy: $\sum_{j\neq i} f_{x_j}(x_j;n) - \sum_j g^i_{y_j}(y:\psi) = 0$. This will lead to different comparative statics, but the main trade-off remains valid. Namely, an improvement in market-supporting institutions will lead to an increase in the market action and an increase in pledgable income. The latter will result in more resources available to invest in the non-market action when the hike in the market payoff results in a large increase in borrowing capacity so that this compensates for the rise in the market action. This requires a low moral-hazard intensity in the capital market so the pass-through from a higher ψ to borrowing is high. The welfare-maximizing criteria is less appropriate that the one chosen because the problem at hand is concerned with members behavior in spot markets and how that affect non-market exchange. If the problem at hand were the selection of an equilibrium in a pure collective action problem, the welfare-maximization criteria seems to be the most appropriate. Furthermore, in our case the welfare-maximizing implies that members collude in the market action, which defy the concept of anonymous market exchange. We can think that the market payoff depends on the actions of unmodeled individuals outside the community.

Second, the model does not allow for community enforcement of market actions. This will change the incentive compatibility constraint in the sense that the equilibrium market and non-market actions must be self-enforcing with respect to a deviation in the market action, in the non-market, and in both simultaneously. Because the punishment is the same regardless of which deviation occurs, if a member wishes to deviate, it is optimal to do so in both actions. So the new incentive constraint is more stringent and therefore the largest self-sustainable non-market action is smaller. In fact, the new incentive constraint will be

$$\begin{aligned} x_i \leq & \delta\Big(\sum_{j\neq i} f(x_j;n) + g^i(y;\psi) + w - y_i - V_i(\phi,\psi,w)\Big) + \\ & (1-\delta)\big(g^i(y^{fb};\psi) - y_i^{fb} - g^i(y_i', y_{-i}^{fb};\psi) - y_i'\big), \end{aligned} \tag{6}$$

where $y_i' \in \mathrm{argmax}_{y_i \leq w + d^{se}}\{g^i(y_i, y_{-i}^{fb};\psi) - y_i\}$.

Because of this, implementing the unconstrained welfare-maximizing action will require a larger discount factor and implementing the welfare-maximizing market action require a large income when externalities are positive and a lower one when they are negative. With community punishments it is possible to implement either the welfare-maximizing or colluding market action profile. Yet, this will not change the main result regarding the complementarity/substitutability between market and non-market exchange and the main mechanism under which it takes place. There will be a difference which is that an increase in ψ will increases the market action's equilibrium payoff.

Third, the model assumes that non-market exchange involves everyone in the community. However, it is easy to assume either random matching or that a the architecture of the community is a network of complete components and non-marke exchange occurs within each component or both, while the whole community takes part in market exchange.

Fourth, information flows perfectly within the whole community. Adding imperfect information flows will lower the expected loss from reneging but will not make the problem fundamentally different. Yet adding incomplete information could make the problem much more complicated and the details will depend on the assumptions with regard to how the information flows within the community.

Fifth, we have assumed identical members. This has been done to facilitate the analysis. Heterogeneity can be added in different dimensions such as initial endowments and different payoffs. Doing this greatly complicate the algebra without further gain in economic intuition. There will be a gain in reality since there would be member that participate in both market and non-market exchange, while other only on market exchange.

7 Conclusions

This paper demonstrates that when initial endowments are low, community members only participate in market exchange, fully crowding out non-market exchange. However, when endowments are neither small nor large, community members engage in both market and non-market exchange. In these cases, the exchanges are complements when the equilibrium payoff from market exchange rises with an improvement in market-supporting institutions. This occurs when uninternalized market externalities are not too negative, and the quality of capital market-supporting institutions is sufficiently high. When initial endowments are large, members also participate in both types of exchange, but the quality of capital market institutions plays no role because members are never financially constrained. Hence, complementarity occurs when endowments are neither small nor large, and communities have well-developed market and capital market-supporting institutions, such as strong creditors' protection, property rights, efficient regulation, low capture, etc.

This paper contributes to our understanding of how market-supporting institutions shape the relationship between market and non-market exchange. It also sheds new light on the debate between those who argue that the expansion of market exchange crowds out non-market exchange and those who assert that market exchange raises the returns from non-market exchange and leads to exchange outside formal markets. The results in this paper rely solely on the rationality of members and the scarcity of resources, without relying on ascriptive characteristics such as morality and trustworthiness. Thus, the crowding-out debate should be abandoned, and the focus should shift to a more productive debate, particularly in terms of public policies, which revolves around the question of under what market conditions market and non-market exchange are complements or substitutes.

The predicted incentive complementarity and the underlying economic mechanism provide key insights into the development or failure of a nation. Improving market-supporting institutions may require significant investments, and this challenge is exacerbated by the fact that complementarity necessitates a minimum endowment level for market and non-market exchange to be possible. This makes it difficult for a society to reap the benefits of exchange complementarity. When a society is poor, it becomes trapped in low-quality market exchange with uninternalized externalities. However, market-supporting institutions alone can help escape this trap by increasing the returns to market exchange for constrained societal members. Once a resource threshold is reached, complementarities can come into play, and investment in both market and capital market institutions should progress in tandem to fully exploit the complementarity.

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A Proofs of Propositions in the Main Text

A Proofs for Section 3 (Preliminary Results)

Proof of Lemma 1. Observe that for any $z \in \{\psi, k, w\}$

$$(nf_{x_i x_i}(x_i; n) + \sum_h \sum_j g^j_{y_i y_h}(y; \psi))x_z(k) = I(z) \sum_h \sum_j g^j_{y_i y_h}(y; \psi) + \sum_j g^j_{y_i z}(y; \psi)$$

and

$$y_z(k) = I(z) - x_z(k) = \frac{I(z) nf_{x_i x_i}(x_i; n) - \sum_j g^j_{y_i z}(y; \psi)}{nf_{x_i x_i}(x_i; n) + \sum_h \sum_j g^j_{y_i y_h}(y; \psi)},$$

where the denominator is negative due to concavity of f and the dominant diagonal condition and $I(z) = 1$ for $z \in \{k, w\}$ and 0 otherwise. □

Proof of Lemma 2. Recall that the highest incentive compatible debt is the highest solution to $(1 + \phi)^{-1}\big(nf(x(k), n) + g^i(y(k); \psi)\big) - \phi(1 + \phi)^{-1}w - d = 0$. Because individuals are resource constrained when they invest $x_i(k) = d + w - y_i(k)$. Due to the monotonicity and concavity of f and the fact that $\sum_j g^i_{y_j}(y(k); \psi) - nf_{x_i}(x(k), n) = 0$ for all k when the credit constraint binds, it must be the case that

$$\frac{1}{1 + \phi} nf_{x_i}(x^{fb}(k), n) - 1 < 0;$$

otherwise, d could be increased without violating the credit constraint. In order to show that $d^{fb}(\psi, \phi, w)$, exits it is sufficient to show that: (i), $x^{fbu} + y^{fbu} - (1 + \phi)^{-1}\big(\sum_{j \neq i} f(x^{fbu}, n) + g^i(y^{fbu}; \psi)\big) > 0$ and (ii) $(1 + \phi)^{-1}\big(nf(x(k), n) + g^i(y(k); \psi)\big) - d$ increases continuously with d. The first follows from 1 and the second follows from the fact that individuals are constrained. Furthermore is established by differentiating the credit constraint, that

$$\frac{dd^{fb}(\psi, \phi, w)}{dw} = -\frac{nf_{x_i}(x^{fb}(k), n) - \phi}{nf_{x_i}(x^{fb}(k), n) - (1 + \phi)}\Big|_{(x,y) = (x^{fbc}, y^{fbc})} > 0. \tag{A1}$$

As argued above the denominator is negative whenever the incentive constraint binds. The numerator is positive due to the fact that when constrained the first-order conditions is $nf_{x_i}(x^{fb}(k), n) > 1 > \phi$. The fact that $d^{fb}(\psi, \phi, w)$ falls with (ψ, ϕ) follows from the fact that $nf(x(k), n) + g^i(y(k); \psi)$ falls with ψ and $(1 + \phi)^{-1}\big(nf(x(k), n) + g^i(y(k); \psi)\big) - \phi(1 + \phi)^{-1}w$ falls with ϕ.

In order to show that there exist a unique endowment threshold we need to show that at $w = 0$, $d^{fb}(\phi, \psi, 0) < x^{fbu} + y^{fbu}$ and that $w + d^{fb}(\phi, \psi, 0)$ rises with w. The former follows from Assumption 1 and the latter from the fact that $w + d^{fb}(\phi, \psi, 0)$ rises with w whenever

$$-\frac{1}{nf_{x_i}(x^{fb}(k), n) - (1 + \phi)}\Big|_{(x,y) = (x^{fbc}, y^{fbc})} > 0,$$

which holds that the fact that members are constrained implies that the denominator is negative. $\square$

Proof of Proposition 1. Observe that for $z \in \{\psi, \phi, w\}$, we have

$$(nf_{x_i x_i}(x_i;n) + \sum_h \sum_j g^j_{y_i y_h}(y;\psi))x^{fb}_z = \sum_h \sum_j g^j_{y_i y_h}(y;\psi)d^{fb}_z(\phi,\psi) + \sum_j g^j_{y_i z}(y;\psi)$$

and

$$y^{fb}_z = I(w) + d^{fb}_z(\phi,\psi) - x^{fb}_z = I(w) + \frac{nf_{x_i x_i}(x_i;n)d^{fb}_z(\phi,\psi) - \sum_j g^j_{y_i z}(y;\psi)}{nf_{x_i x_i}(x_i;n) + \sum_h \sum_j g^j_{y_i y_h}(y;\psi)} > 0$$

where
$$\frac{dd^{fb}(\psi,\phi,w)}{dw} = -\frac{nf_{x_i}(x^{fb}(k),n) - \phi}{nf_{x_i}(x^{fb}(k),n) - (1+\phi)}\Big|_{(x,y)=(x^{fbc},y^{fbc})} > 0.$$
and $I(\phi) = 1$ if $z = \phi$ and $I(w) = 1$ if $z = w$, and

$$\frac{dd^{fb}(\psi,\phi,w)}{d\psi} = -\frac{g^i_\psi + (\sum_j g^i_j - nf_i)y^{fbc}_{psi} -}{nf_{x_i}(x^{fb}(k),n) - (1+\phi)}\Big|_{(x,y)=(x^{fbc},y^{fbc})} > 0.$$

It readily follows from this that if $w < w^{fbc}(\phi,\psi)$, $x^{fb}_\psi > 0$ if and only if

$$\left(-\frac{g^i_\psi(y;\psi)\sum_h \sum_j g^j_{y_i y_h}(y;\psi)}{\sum_j g^j_{y_i}(y;\psi) - (1+\phi)} + \sum_j g^j_{y_i \psi}(y;\psi)\right)\Big|_{(x,y)=(x^{fbc},y^{fbc})} < 0$$

and $y^{fb}_\psi > 0$ if and only if

$$-\left(\frac{g^i_\psi(y;\psi)nf_{x_i x_i}(x_i;n)}{\sum_j g^j_{y_i}(y;\psi) - (1+\phi)} + \sum_j g^j_{y_i \psi}(y;\psi)\right)\Big|_{(x,y)=(x^{fbc},y^{fbc})} < 0,$$

which always hold. $\square$

Proof of Lemma 3. Observe that the LHS of $d = (1+\phi)^{-1}g^i(w+d,\dots,w+d;\psi) - (1+\phi)^{-1}\phi w$ is increasing d and it is 0 at $d = 0$, while the RHS is positive and non-increasing when $\sum_j g^i_{y_j}(y(d);\psi) \leq 0$ and increasing otherwise. In the first case, the Intermediate Value theorem ensures that there is a unique symmetric solution, while in the latter this together with the dominant diagonal condition –for each i, $\sum_j g^i_{y_j}(y(d);\psi)$ decreases with d– guarantee also that there is a unique symmetric solution. Let's denote this solution by $d^{se}(\phi,\psi,w)$. Because $1 - (1+\phi)^{-1}\sum_j g^i_{y_j}(y(d);\psi) > 0$ whenever the credit constraint binds, otherwise it could increase debt, $d^{se}(\phi,\psi,w)$ increases with ψ since g^i rises with it, decreases with ϕ since $(1+\phi)^{-1}$ falls and $(1+\phi)^{-1}$ rises with ϕ, and increases with w whenever $\sum_j g^i_{y_j}(y(d);\psi) - \phi > 0$.[25]

[25] Observe that a necessary condition for the credit constraint to bind is that $\phi < 2$.

Next, observe that $w + d^{se}(\phi, \psi, w)$ increases with w since it its slope is given by

$$\frac{1}{1 + \phi - \sum_j g^i_{y_j}(y(d); \psi)} > 0$$

where the inequality follows from the fact that the denominator is positive. This, together with Assumption 2, ensure that the existence of an endowment threshold, denoted by $w^{se}(\phi, \psi)$, such that the members are unconstrained whenever $w \geq w^{se}(\phi, \psi)$.

Because $w + d^{se}(\phi, \psi, w) = y^{seu}$ at $w = w^{se}(\phi, \psi)$, it is easy to check that $w^{se}_\psi(\phi, \psi) = \big(y^{seu}_\phi(1 + \phi - \sum_j g^i_j) = g^i_\psi\big)|_{y^{seu}}$ and

$$w^{se}_\phi(\phi, \psi) = -\frac{1}{(1+\phi)^2} \frac{g^i + w}{1 + \phi - \sum_j g^i_j}\Big|_{y^{seu}}$$

□

Proof of Proposition 5. If $w < w^{se}(\phi, \psi)$,

$$V_w(\phi, \psi, w) \in (0, 1) = \frac{1 + \phi}{1 + \phi - \sum_i g^i_{y_i}(y(d); \psi)}\Big|_{y = w + d^{se}} > 0.$$

If $w \geq w^{se}(\phi, \psi)$, $V_\psi(\phi, \psi, w) > 0$ if and only if

$$g^i_\psi \sum_j g^i_{y_i y_j}(y^{seu}; \psi) - g^i_{y_i \psi} \sum_{j \neq i} g^i_{y_j}(y^{seu}; \psi) \leq 0,$$

while if $w < w^{se}(\phi, \psi)$,

$$V_\psi(\phi, \psi, w) \in (0, 1) = \frac{(1 + \phi) g^i_\psi}{1 + \phi - \sum_i g^i_{y_i}(y(d); \psi)}\Big|_{y = w + d^{se}} > 0.$$

If $w \geq w^{se}(\phi, \psi)$, $V_\phi(\phi, \psi, w) = 0$, while if $w < w^{se}(\phi, \psi)$,

$$V_\phi(\phi, \psi, w) \in (0, 1) = \frac{g^i + w}{1 + \phi} \frac{1 - \sum_i g^i_{y_i}}{1 + \phi - \sum_i g^i_{y_i}(y(d); \psi)}\Big|_{y = w + d^{se}} > 0.$$

$V_\phi(\phi, \psi, w) > 0$ if and only if $\sum_j g^i_{y_j}(y(d^{se}); \psi) < 1$. □

B Proofs for Section 4 (The Dynamic Equilibrium)

Proof of Lemma 4. Let's define $x(\delta)$ as the unique solution to $\delta \sum_{j \neq i} f_{x_i}(x, n) - 1 = 0$. Then, $x(\delta, y)$ exists if and only if $x(\delta) \leq \delta\big(\sum_{j \neq i} f(x(\delta), n) + g^i(y; \psi) + w - y_i - V_i(\phi, \psi, w)\big)$. This requires that $V_i(\phi, \psi, w) \leq \sum_{j \neq i} f(x(\delta), n) - \frac{x(\delta)}{\delta} + g^i(y; \psi) - y_i + w$. Observe that the RHS is positive and and the LHS is increasing and belongs to $\Re_+$. Hence, existence follows from the concavity of f and the intermediate value Theorem.

Let $V_i(\delta)$ the solution to the equation with equality. For $V_i(\phi,\psi,w) < V_i(\delta)$,

$$x_{y_i}(\delta, y) = \frac{\delta(g^i_{y_i}(y;\psi) - y_i)}{1-\delta\sum_{j\neq i} f_{x_i}(x,n))}\Big|_{x(\delta,y)}.$$

Hence, $x(\delta, y) > 0$ rises with y for all $y_i \leq y^{seu}$ since $g^i(y;\psi) - y_i$ rises with y_i in this range and $(1-\delta\sum_{j\neq i} f_{x_i}(x,n))|_{x(\delta,y)} > 0$.

$$x_w(\delta, y) = \frac{\delta(1 - V_w(\phi,\psi,w))}{1-\delta\sum_{j\neq i} f_{x_i}(x,n))}\Big|_{x(\delta,y)}.$$

where $V_w(\phi,\psi,w) = 1$ if $w \geq w^{se}(\phi,\psi)$ and $V_w(\phi,\psi,w) = \frac{1+\phi}{1+\phi-\sum_i g^i_{y_i}(y(d);\psi)}\Big|_{y=w+d^{se}}$ if $w < w^{se}(\phi,\psi)$. Hence, $x_w(\delta,y) \geq 0$ whenever $\sum_i g^i_{y_i}(y(d);\psi)\Big|_{y=w+d^{se}} \leq 0$ since $V_w(\phi,\psi,w) \in (0,1]$ and $(1-\delta\sum_{j\neq i} f_{x_i}(x,n))|_{x(\delta,y)} > 0$. Otherwise, $x_w(\delta,y) < 0$

The other comparative statics are straightforward.

Because for all $V_i(\phi,\psi,w) < V_i(\delta)$, $x(\delta,y)$ rises with δ and $g^i(y^{seu};\psi)+w-y^{seu}_i-V_i(\phi,\psi,w) \geq 0$ and f is concave, $\delta^u(\phi,\psi,w)$ exists and is unique. □

Proof of Proposition 6. In what follows, we will assume that payoffs, endowments, and debt levels are identical, and focus on symmetric equilibria.

Provided that the income constraint does not bind and that member i believes that the other players will play $(\min\{x^{fbu}, x(\delta,y)\}, y^{seu})$, if $\delta \geq \delta^u(\phi,\psi,w)$, member i will choose y_i to maximizes $g^i(y;\psi) + w - y_i$, while if $\delta < \delta^{fbu}(\phi,\psi,w)$, he will choose to maximize

$$\sum_{j\neq i} f(x_j, n) + g^i(y;\psi) + w - y_i - x(\delta, y).$$

Hence, the best-response $BR^u(y_{-i})$ is the unique solution to $g^i_{y_i}(y;\psi) - 1 = 0$ and $BR^u(x_{-i}, y_{-i}) = x(\delta,y)$ if $\delta < \delta^u(\phi,\psi,w)$ and $BR^u(x_{-i}, y_{-i}) = x^{fbu}$ if $\delta \geq \delta^u(\phi,\psi,w)$. Hence, in a symmetric equilibria, $y = y^{seu}$, $x = x^{fbu}$ if $\delta \geq \delta^u(\phi,\psi,w)$ and $x^{deu}(\delta) \equiv x(\delta, y^{seu})$. This is feasible whenever $k \geq k^u(\delta)$.

If $k < k^u(\delta)$ and that member i believes that the other players will play $(k - y^{seu}, y^{seu})$. Member i best-response is $BR^u(y_{-i}) = y^{seu}$ and $BR^u(x_{-i}, y_{-i}) = k - y^{seu}$. Hence, in a symmetric equilibria, $y = y^{seu}$, $x = k - y^{seu}$. This occurs whenever $k \geq k^c$.

If $k < k^c$ and member i believes that the other players will play $(0, k)$, member i's best responses is given by $BR^c(y_i) = k$ and $BR^c(0, k) = 0$.

□

Proof of Lemma 5. $w^{deu}(\phi, \psi, \delta)$ must solve the following

$$\begin{aligned}&\min\{x^{fbu}, x^{deu}(\delta)\} + y^{seu}) - w = \\ &(1+\phi)^{-1}\big(nf(\min\{x^{fbu}, x^{deu}(\delta)\}, n) + g^i(y^{seu}; \psi)\big) - \phi(1+\phi)^{-1}w.\end{aligned}$$

If $\delta \geq \delta^u(\phi, \psi, w)$, this becomes

$$-(1+\phi)^{-1}w = (1+\phi)^{-1}\big(nf(x^{fbu}, n) + g^i(y^{seu}; \psi)\big) - x^{fbu} - y^{seu} > 0.$$

and thereby w exists and its unique since the RHS independent of w and it is positive due to Assumption **??**. If $\delta < \delta^u(\phi, \psi, w)$, then

$$-(1+\phi)^{-1}w = (1+\phi)^{-1}\big(nf(x^{deu}(\delta), n) + g^i(y^{seu}; \psi)\big) - x^{deu}(\delta) - y^{seu}) - w.$$

Recall that $x^{deu}(\delta)$ rises with w whenever $\sum_i g^i_{y_i}(y(d); \psi)\big|_{y=w+d^{se}} \leq 0)$. Hence, the LHS rises with w and the RHS falls whenever $\sum_i g^i_{y_i}(y(d); \psi)\big|_{y=w+d^{se}} \leq 0$ since the incentive constraint binds and thereby $nf(x^{deu}, n) - (1+\phi) < 0$. Hence, in this case by the intermediate value theorem there exits a unique w that solves the equation. When $\sum_i g^i_{y_i}(y(d); \psi)\big|_{y=w+d^{se}} > 0$, uniqueness follows from the fact that this is decreasing due to the diagonal-dominance property. Because $x^{deu}(\delta)$ rises with δ and $nf(x^{deu}, n) - (1+\phi) < 0$, w^{deu} increases with it. Since $x^{deu}(\delta)$ is independent of ϕ and an increase in ϕ tightens the credit constraint, w^{deu} also increases with it. Finally, because $\sum_j g^i_j(y^{seu}; \psi) - (1+\phi) < 0$ and y^{seu} increases with ψ, w^{deu} also increases with it.

Next, recall that the highest incentive compatible debt is the highest solution to $(1+\phi)^{-1}\big(nf(x(k), n) + g^i(y(k); \psi)\big) - \phi(1+\phi)^{-1}w - d = 0$.

Because individuals are resource constrained when they invest $x_i(k) = \max\{0, d+w-y_i(k)\}$. We have two cases to consider, when $d + w < y^{seu}$, in which case $x(k) = 0$ and the case in which $d+w \geq y^{seu}$. In the former case, we have that the LHS falls with d since $\sum_j g^i_j(y(k); \psi) - (1+\phi) < 0$ when constrained; otherwise it could increase debt without violating the incentive constraint, while in the latter the slope is $nf_{x_i}(x^{fb}(k), n) - (1+\phi) < 0$.

In order to show that d^{dec} exits it is sufficient to show that: (i), $x(k) + y^{seu} - (1+\phi)^{-1}\big(\sum_{j\neq i} f(x(k), n) + g^i(y^{seu}; \psi)\big) > 0$; and (ii) $(1+\phi)^{-1}\big(nf(x(k), n) + g^i(y(k); \psi)\big) - \phi(1+\phi)^{-1}w - d$. decreases continuously with d. The first follows from **??** and the second follows from the fact that individuals are credit constrained. Furthermore, it is established by differentiating the credit constraint that, if $d + w \geq y^{seu}$,

$$\frac{dd^{dec}}{dw} = -\frac{nf_{x_i}(x, n) - \phi}{nf_{x_i}(x, n) - (1+\phi)}\Big|_{(x,y)=(x^{deu}, y^{seu})} > 0, \qquad \text{(B2)}$$

while if $d + w < y^{seu}$,

$$\frac{dd^{dec}}{dw} = -\frac{\sum_j g^i_j(y(k);\psi) - \phi}{\sum_j g^i_j(y(k);\psi) - (1+\phi)}\Big|_{(x,y)=(0,d+w)}, \tag{B3}$$

where the inequality in the first case follows from the fact that $nf_{x_i^{deu}}(x,n) > 1 > \phi$ since member are constrained and do not invest x^{fbu}, while in the latter follows when $\sum_j g^i_j(y(k);\psi) > \phi$ since even when the individual is constrained he does not internalized externalities and therefore $g^i_i() > 1$, but this does not imply that $\sum_j g^i_j(y(k);\psi) > \phi$.

$$\frac{dd^{dec}}{d\psi} = -\frac{g^i_\psi - (nf_i - \sum_j g^i_j)y^{seu}_\psi}{nf_{x_i}(x,n) - (1+\phi)}\Big|_{(x,y)=(x^{deu},y^{seu})} > 0, \tag{B4}$$

while if $d + w < y^{seu}$,

$$\frac{dd^{dec}}{d\psi} = -\frac{g^i_\psi}{\sum_j g^i_j(y(k);\psi) - (1+\phi)}\Big|_{(x,y)=(0,d+w)} > 0, \tag{B5}$$

$$\frac{dd^{dec}}{d\psi} = -\frac{1}{1+\psi}\frac{nf(x(k),n) + g^i(y(k);\psi)}{nf_{x_i}(x,n) - (1+\phi)}\Big|_{(x,y)=(x^{deu},y^{seu})} > 0, \tag{B6}$$

while if $d + w < y^{seu}$,

$$\frac{dd^{dec}}{d\psi} = -\frac{1}{1+\psi}\frac{+g^i}{\sum_j g^i_j(y(k);\psi) - (1+\phi)}\Big|_{(x,y)=(0,d+w)} > 0, \tag{B7}$$

The fact that d^{dec} falls with (ψ,ϕ) follows from the fact that $nf(x(k),n) + g^i(y(k);\psi)$ falls with ψ and $(1+\phi)^{-1}\big(nf(x(k),n) + g^i(y(k);\psi)\big) - \phi(1+\phi)^{-1}w$ falls with ϕ. Observe that if $d^{dec}(\phi,\psi,w) + w < y^{seu}$, then $d^{dec}(\phi,\psi,w) = d^{se}(\phi,\psi,w)$ since $x(k) = 0$.

Next, observe that $w + d^{dec}(\phi,\psi,w)$ whenever $x(k) = 0$ increases with w since it its slope is given by

$$\frac{1}{1+\phi-\sum_j g^i_{y_j}(y(d);\psi)} > 0$$

where the inequality follows from the fact that the denominator is positive. This, together with Assumption 2, ensure that the existence of an endowment threshold, denoted by $w^{se}(\phi,\psi)$, such that the members are unconstrained whenever $w \geq w^{se}(\phi,\psi)$ □

Proof of Proposition 8. Recall that $w^{dec}(\phi,\psi,\delta)$ is the unique solution to the equation $y^{seu} = w + d^{dec}(\phi,\psi,w,\delta)$, where $d^{dec}(\phi,\psi,w,\delta)$ solves $d^{se}(1-\phi)(nf(w + d^{se}y^{seu};n) + g^i(y^{seu};\psi))$, and $w^{se}(\phi,\psi)$ is the unique solution to $y^{seu} = w + d^{se}de(\phi,\psi,w)$, where $d^{se}(\phi,\psi,w)$ solves $d^{se}(1-\phi)g^i(w + d^{se}\psi))$. Hence, $d^{se}(\phi,\psi,w) < d^{dec}(\phi,\psi,w,\delta)$ and thereby $w^{dec}(\phi,\psi,\delta) < w^{se}(\phi,\psi)$.
□

C Proofs for Section 5 (Dynamic Equilibrium: The Role of Market-Supporting Institutions)

Proof of Proposition 9. First, $w \geq w^{deu}(\phi, \psi, \delta)$ and $\delta \geq \delta^{u}(\phi, \psi, w)$. Then, $x_z^{de} = x_z^{fbu}$ and $y_z^{de} = y_z^{seu}$, where $d^{de}(\psi, w) = y^{seu} + x^{fbu} - w$. Hence, $x_z^{de} = 0$ for any $z \in \{\psi, \phi, w\}$ and $y_\phi^{de} = 0$, $y_w^{de} = 0$, and $y_\psi^{de} > 0$ if and only if $g^i(y^{seu}; \psi) - y^{seu}$ rises with ψ. This entails the following

$$\Big(g_\psi^i(y;\psi) - \frac{g_{y_i\psi}^i(y;\psi)}{\sum_j g_{y_iy_j}^i(y;\psi)} \sum_{j\neq i} g_{y_j}^i(y;\psi)\Big)\Big|_{y^{seu}} \geq \frac{(1+\phi)g_\psi^i(y);\psi)}{1+\phi-\sum_j g_{y_j}^i(y;\psi)}\Big|_{y(d^{se})}.$$

Next, let's assume that $w \geq w^{deu}(\phi, \psi, \delta)$ and $\delta < \delta^{u}(\phi, \psi, w)$. Hence, $y_\psi^{de} > 0$ if and only if $g^i(y^{seu}; \psi) - y^{seu}$ rises with ψ, and $y_\phi^{de} = y_w^{de} = 0$. In this case, $x_z^{de} = x^{deu}(\delta)$. Because $w^{deu}(\phi, \psi, \delta) > w^{se}(\phi, \psi)$, $g^i(y^{seu}; \psi) - y^{seu} - V(\phi, \psi, w) = 0$. It readily follows form this that $x_w^{de} > 0$, and $x_\psi^{de} = x_\phi^{de} = 0$. □

Proof of Proposition 10. Observe that $x_z^{de} = I_z(w) + d_z^{dec}(\phi, \psi, w, \delta) - y_z^{de}$, where $d^{dec}(\phi, \psi, w, \delta)$ is the unique solution to $d = (1+\phi)^{-1}(nf(w + d^{se} - y^{seu}; n) + g^i(y^{seu}; \psi)) - (1+\phi)\phi^{-1}w$.

Recall that

$$\frac{dd^{dec}}{dw} = -\frac{nf_{x_i}(x,n) - \phi}{nf_{x_i}(x,n) - (1+\phi)}\Big|_{(x,y)=(x^{deu}, y^{seu})} > 0, \tag{C8}$$

$$\frac{dd^{dec}}{d\psi} = -\frac{g_\psi^i + (\sum_j g_j^i - nf_{x_i}(x,n))y_\psi^{seu}}{nf_{x_i}(x,n) - (1+\phi)}\Big|_{(x,y)=(x^{deu}, y^{seu})}, \tag{C9}$$

$$\frac{dd^{dec}}{d\phi} = -\frac{1}{(1+\phi)^2}\frac{nf_{x_i}(x,n) + g^i(y^{seu};\psi) - \phi}{nf_{x_i}(x,n) - (1+\phi)}\Big|_{(x,y)=(x^{deu}, y^{seu})} > 0, \tag{C10}$$

Because y^{seu} is independent of (ϕ, w). Implicitly differentiating, we obtain that

$$x_w^{de} = 1 + d_w^{dec}(\phi, \psi, w, \delta) = \frac{1}{1+\phi - nf_{x_i}(x,n)}\Big|_{(w+d^{dec}-y^{seu}, y^{seu})} > 0,$$

$$x_\phi^{de} = d_\phi^{dec}(\phi, \psi, w, \delta) = -\frac{1}{1+\phi}\frac{nf(x;n) + g^i(y:\psi) + w}{1+\phi - nf_{x_i}(x,n)}\Big|_{(w+d^{dec}-y^{seu}, y^{seu})} < 0$$

and

$$x_\psi^{de} = d_\psi^{dec}(\phi, \psi, w, \delta) - y_\psi^{seu} = \frac{g_\psi^i + ((\sum_{j\neq i} g_j^i) - (1+\phi))y_\psi^{seu}}{1+\phi - nf_{x_i}(x,n)}\Big|_{(w+d^{dec}-y^{seu}, y^{seu})} > 0,$$

Hence, if $g_\psi^i + ((\sum_{j\neq i} g_j^i) - (1+\phi^{de}))y_\psi^{seu} > 0$, then there exists a threshold $\hat{\phi}^{de}$ such that x_ψ^{de} if and only if $\phi < \psi^{de}$.

□

Proof of Proposition 11. Because the equilibrium is identical to the static equilibrium, the proof is identical to that given in Proposition **??** □

Proof of Proposition 12. If $w \geq w^{deu}(\phi, \psi, \delta)$, then

$$V(\phi, \psi, w, \delta) = nf(\min\{x^{fbu}, x^{deu}(\delta)\}; n) + g^i(y^{seu}; \psi) + w - y^{seu} - \min\{x^{fbu}, x^{deu}(\delta)\}.$$

If $\delta \geq \delta^u(\phi, \psi, w)$, this is increasing if and only if $\Big(g^i_\psi(y; \psi) - \frac{g^i_{y_i\psi}(y;\psi)}{\sum_j g^i_{y_i y_j}(y;\psi)} \sum_{j\neq i} g^i_{y_j}(y;\psi)\Big)\Big|_{y^{seu}} > 0$, while if $\delta < \delta^u(\phi, \psi, w)$, $V(\phi, \psi, w, \delta)$ rises with ψ if and only if

$$\Big((nf_i - 1)x^{de} - \psi + (\sum jg^i + j - 1)y^{seu}_\psi\Big)\Big|_{(x^{deu}(\delta), y^{seu})} > 0,$$

which after the proper substitutions

$$\Big((nf_i - 1)\delta \frac{(g^i_\psi + (\sum_j g^i_j - 1)y^{seu}_\psi - V_\psi(\phi, \psi, w))}{1 - \delta nf_i} + g^i_\psi + (\sum_j g^i_j - 1)y^{seu}_\psi\Big)\Big|_{(x^{deu}(\delta), y^{seu})} > 0,$$

where $V_\psi(\phi, \psi, w) = (g^i_\psi + (\sum_j g^i_j - 1)y^{seu}_\psi)|_{y^{seu}}$ if $w \geq w^{se}(\phi, \psi)$, and $V_\psi(\phi, \psi, w) = \frac{\phi g^i_\psi(y); \psi)}{1+\phi-\sum_j g^i_{y_j}(y;\psi)}\Big|_{w+d^{se}(\phi,\psi)} > 0$ if $w < w^{se}(\phi, \psi)$.

Because $\min\{x^{fbu}, x^{deu}(\delta)\} - (1 - \phi)\sum_{j\neq i} f(\min\{x^{fbu}, x^{deu}(\delta)\}; n) \geq 0$, $w^{deu}(\phi, \psi, \delta) \geq w^{se}(\phi, \psi)$, welfare increases with ψ if and only if $V_\psi(\phi, \psi, w) > 0$ and and raises with w if and only if

$$\Big(1 - \delta nf_{x_i}(x; n))V_w(\phi, \psi, w)\Big)\Big|_{(x^{deu}(\delta), y^{seu})} > 0.$$

where the inequality follows from the that the incentive-compatibility constrain binds and therefore $1 - \delta nf_{x_i}(x; n) > 0$

If $w^{dec}(\phi, \psi, \delta) \leq w < w^{deu}(\phi, \psi, \delta)$ is given by

$$V(\phi, \psi, w, \delta) = \phi(1 + \theta)^{-1}\big(nf(w + d^{dec}(\phi, \psi, w, \delta) - y^{seu}; n) + g^i(y^{seu}; \psi) + w\big).$$

Observe that by differentiating the welfare function and substituting the corresponding terms, we get

$$\frac{\partial V(\phi, \psi, w, \delta)}{\partial w} = \big(nf(w + d^{dec}(\phi, \psi, w, \delta) - y^{seu}; n) + g^i(y^{seu}; \psi) + w\big)\frac{1 - nf_{x_i}(x; n))(1 - nf_{x_i}(x; n))}{1 + \phi - nf_{x_i}(x; n)}\Big|_{(w+d^{dec}-y$$

$$\frac{\partial V(\phi, \psi, w, \delta)}{\partial w} = \frac{\phi}{1 + \phi}\frac{1 + \phi}{1 + \phi - nf_{x_i}(x; n)}\Big|_{(w+d^{dec}-y^{seu}, y^{seu})} > 0.$$

and

$$\frac{\partial V(\phi,\psi,w,\delta)}{\partial\psi} = \phi\frac{(g_\psi^i + (\sum_j g_{y_j}^i - nf_{x_i})y_\psi^{seu}}{1+\phi-nf_{x_i}(x;n)}\Big|_{(w+d^{dec}-y^{seu},y^{seu})}\Big|_{(w+d^{dec}-y^{seu},y^{seu})}.$$

Hence, this is positive if and only if $g_\psi^i + (\sum_j g_{y_j}^i - nf_{x_i})y_\psi^{seu} > 0$.

If $w < w^{dec}(\phi,\psi,\delta)$, The equilibrium is identical to the static equilibrium when the members are credit constrained and thus the proof is identical to that in Lemma 3.

□